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136. Volcanic Rocks of South Mountain, Pennsylvania, by Florence Bascom.

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138. Artesian-well Prospects in the Atlantic Coastal Plain Region, by N. H. Darton.

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Mineral Resources of the United States, 1886, by David T. Day. 1887. 8°. viii, 813 pp. Price 50 cents.

Mineral Resources of the United States, 1887, by David T. Day. 1888. 8°. vii, 832 pp. Price 50 cents.

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Mineral Resources of the United States, 1891, by David T. Day. 1893. 8°. vii, 630 pp. Price 50 cents.

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Mineral Resources of the United States, 1893, by David T. Day. 1894. 8°. viii, 810 pp. Price 50 cents.

On March 2, 1895, the following provision was included in an act of Congress:

"*Provided*, That hereafter the report of the mineral resources of the United States shall be issued as a part of the report of the Director of the Geological Survey."

In compliance with this legislation, the report Mineral Resources of the United States for the Calendar Year 1894 forms Parts III and IV of the Sixteenth Annual Report of the Survey.

The money received from the sale of these publications is deposited in the Treasury, and the Secretary of the Treasury declines to receive bank checks, drafts, or postage stamps; all remittances, therefore, must be by POSTAL NOTE or MONEY ORDER, made payable to the Director of the U. S. Geological Survey, or in CURRENCY, for the exact amount. Correspondence relating to the publications of the Survey should be addressed

TO THE DIRECTOR OF THE
UNITED STATES GEOLOGICAL SURVEY,
WASHINGTON, D. C.

WASHINGTON, D. C., *March, 1896.*

DEPARTMENT OF THE INTERIOR

BULLETIN

OF THE

UNITED STATES

GEOLOGICAL SURVEY

No. 130



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1896

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

BIBLIOGRAPHY AND INDEX

OF

NORTH AMERICAN GEOLOGY, PALEONTOLOGY, PETROLOGY, AND MINERALOGY

FOR

1892 AND 1893

BY

FRED BOUGHTON WEEKS



WASHINGTON

GOVERNMENT PRINTING OFFICE

1896

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LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
DIVISION OF GEOLOGY,
Washington, D. C., April 30, 1895.

SIR: I have the honor to transmit herewith the manuscript of a Bibliography and Index of North American Geology, Paleontology, Petrology, and Mineralogy for the years 1892 and 1893, by Mr. F. B. Weeks, with the recommendation that it be published by the Survey. I believe that the work has been well done, and that the publication will be a useful one.

Very respectfully,

S. F. EMMONS,
Geologist.

Hon. CHARLES D. WALCOTT,
Director United States Geological Survey.

BIBLIOGRAPHY AND INDEX OF NORTH AMERICAN GEOLOGY, PALEONTOLOGY, PETROLOGY, AND MINERALOGY FOR 1892 AND 1893.

By Fred Boughton Weeks.

INTRODUCTION.

This Bibliography and Index is a continuation of the Record of North American Geology by N. H. Darton,[1] though the scope of the work and its arrangement have been materially changed. The last Record, Bulletin No. 99, embraced publications on geology for 1891. The present work covers the years 1892 and 1893 and consists of a record of the papers on North American geology, paleontology, petrology, and mineralogy contained in the List of Publications following.

Bibliography.—The Bibliography consists of full titles of separate papers, classified by authors, an abbreviated reference to the publication in which the paper is printed, and a brief summary of the contents, each paper being numbered for index reference. The extent of papers less than a single page in length is indicated, as $\frac{1}{3}$ p., 5 l. (lines).

Index.—The subject headings, their subdivisions and arrangement, are shown in the Classified Key to the Index. They comprise geographic, geologic, mineralogic, paleontologic, and petrologic subdivisions. Under Economic Geology is given a list of useful minerals and ores described in publications examined; under Mineralogy, a list of minerals described in such publications; under Paleontology, a list of genera and species of fossils therein described; and under Petrology, a list of rocks described; reference being made in each case, by author's name and number of article in the Bibliography, to the paper in which the fossil, mineral, or rock is described.

The author is under many obligations to different members of the Survey for suggestions as to the general character and arrangement of the material comprised in this volume.

[1] Bibliography of North American Geology for 1886, by Nelson H. Darton; Bull. U. S. Geol. Survey No. 44, 35 pp., 8°, 1887. Record of North American Geology for 1887 to 1889, inclusive, by Nelson Horatio Darton; Bull. U. S. Geol. Survey No. 75, 173 pp., 8°, 1891. Record of North American Geology for 1890, by Nelson Horatio Darton; Bull. U. S. Geol. Survey No. 91, 88 pp., 8°, 1891. Record of North American Geology for 1891, by Nelson Horatio Darton; Bull. U. S. Geol. Survey No. 99, 73 pp., 8°, 1892.

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1 **Adams** (Frank D.). On the typical Laurentian area of Canada.

Jour. of Geol., vol. i, pp. 325–340.

Gives the results of a detailed study of the Laurentian rocks of the Grenville district in Quebec, including a description of the fundamental gneiss, the Grenville, Anorthosite, and Hasting series, and the orographic movements to which they have been subjected.

2 —— On a melilite-bearing rock (alnoite) from Ste. Anne de Bellevue, near Montreal, Canada.

Am. Jour. Sci., 3d ser., vol. xliii, pp. 269–279.

Abstract: Am. Nat., vol. xxvi, p. 697.

Describes the formation occurring in the bed of the river and its mineralogic constituents. Differs from original alnoite in containing more olivine. Probably connected with volcanic center of Mount Royal.

3 —— Ueber das Norian oder Ober-Laurentian von Canada.

Neues Jahrbuch für Mineralogie, Geologie, und Palaeontologie, 1892, pp. 419–498.

Abstracts: Am. Nat., vol. xxvii, p. 564; Am. Jour. Sci., 3d ser., vol. xlvi., pp. 153–154 (⅓ p.).

4 —— Notes to accompany a tabulation of the igneous rocks based on the system of Prof. H. Rosenbusch.

Can. Rec. Sci., vol. iv, pp. 463–469.

Abstract: Am. Geol., vol. ix, pp. 268–269.

Noticed in record for 1891.

5 **Agassiz** (Alexander). Calamocrinus diomedæ, a new stalked crinoid, with notes on the apical system and the homologies of echinoderms.

Harv. Mus. Comp. Zool., Memoirs, vol. xvii, No. 2, pp. 5–95, pls. i–xxxii.

Gives an account of the confusion that has arisen in the nomenclature of the primary divisions of echinoderms. Describes the structure of the new crinoid.

6 —— Reports on the dredging operations off the west coast of Central America to the Galapagos, to the west coast of Mexico, and in the Gulf of California, in charge of Alexander Agassiz, carried on by the U. S. Fish Commission steamer *Albatross*, Lieut. Commander Z. L. Tanner, U. S. N., commanding.

Harv. Mus. Comp. Zool., Bull., vol. xxiii, No. 1, pp. 1–89, pls. i–xxii.

Gives a brief account of the expedition, and a description of the character of the deep-sea deposits as shown by dredgings.

7 **American Geologist.** Pleistocene papers at the Rochester meetings.

Am. Geol., vol. x, pp. 217–224.

Abstracts of papers read before the Geological Society of America at its sessions in Rochester, N. Y., Aug. 15–22, 1892.

8 —— Pleistocene papers read at the Ottawa meeting of the Geological Society of America.

Am. Geol., vol. xi, pp. 171–179 and pp. 241–245.

Gives abstracts of papers and discussions concerning glacial deposits and phenomena.

9 —— Pleistocene papers at the Madison meetings.

Am. Geol., vol. xii, pp. 165–181.

Contains abstracts of papers and discussion on Pleistocene geology.

10 —— Reviews of the Ice age at the World's Congress on Geology.

Am. Geol., vol. xii, pp. 223–231.

Gives abstracts of papers on glacial succession.

10*a* **American Journal of Science.** [Papers read at the Madison meeting of the Geological Society of America.]

Am. Jour. Sci., 3d ser., vol. xlvi, pp. 302–306.

Gives a list of papers read and brief abstracts of their contents.

11 **American Journal of Science.** Geological Congress at Chicago.

Am. Jour. Sci., 3d ser., vol. xlvi, pp. 306–307.

Gives list of papers presented.

12 **Ami** (Henry M.). Notes and descriptions of some new or hitherto unrecognized species of fossils from the Cambro-Silurian (Ordovician) rocks of the Province of Quebec.

Can. Rec. Sci., vol. v, pp. 96–103.

Describes species of Bryozoa, including Solenopora compacta Billings, var. minuta, n. var., Dicranopora parva n. sp., Prasopora lycoperdon Vanuxem, var. selwyni, n. var., Diplotrypa quebecensis n. sp., and Monotrypa incerta n. sp., and two doubtful species.

13 —— Paleontological notes.

Can. Rec. Sci., vol. v, pp. 104–108.

Gives a list of fossils found in the three Ordovician terranes along L'Assumption River and a list of Ordovician species collected from the Manitou Islands, Lake Nipissing, Ontario. At several points the islands consist of sedimentary strata, while the lake shores are completely made up of Archean rocks.

14 —— The Utica terrane in Canada.

Can. Rec. Sci., vol. v, pp. 166–183 and 234–246.

Describes the stratigraphic and lithologic characters of this formation, and gives lists of fossils, which number about sixty forms, mark a special horizon of the Ordovician, and show an affinity to the fauna of the overlying Hudson River and underlying Trenton.

15 —— Additional notes on the geology and paleontology of Ottawa and its environs.

Ottawa Nat., vol. vi, pp. 73–78.

Includes brief description of Silurian strata and some Pleistocene deposits in this vicinity and names of fossils found in them.

16 **Ami** (Henry M.). Notes on the geology and paleontology of the Rockland quaries and vicinity in the county of Russell, Ontario, Canada.

Ottawa Nat., vol. vii, pp. 138-147.

Describes the geologic features of the region, including a description of the Potsdam, Calciferous and Chazy, and Black River and Trenton series and an account of the megascopic and microscopic characters of the Rockland limestone and a list of fossils collected at the quarries.

17 —— On the sequence of strata forming the Quebec group of Logan and Billings, with remarks.

Abstract: Ottawa Nat., vol. vi, pp. 41-43.

Discusses the relations of the strata composing this group and gives a table showing the formations comprising the Ordovician system.

18 —— Extinct Canadian vertebrates from the Miocene rocks of the Northwest Territories of Canada.

Abstract: Ottawa Nat., vol. v, pp. 74–76.

Describes Menodus angustigenis, Elotherium mortoni Leidy, and Leptomeryx mammifer Cope, and mentions other extinct forms.

19 **Arey** (Albert L.). Preliminary notice of the discovery of strata of the Guelph formation in Rochester, N. Y.

Roch. Acad. Sci., Proc., vol. ii, pp. 104–107.

Describes the outcrop and gives a table comparing its fauna with those of the Guelph formation of Canada, Wisconsin, and other localities.

19*a* **Argall** (Philip). [Gold-bearing quartz.]

Colo. Sci. Soc., Proc., vol. iv, pp. 331–336.

In discussion of paper by T. A. Rickard on certain dissimilar occurrences of gold-bearing quartz.

19*b* —— [Origin of ore deposits.]

Colo. Sci. Soc., Proc., vol. iv, pp. 353–354.

In discussion of paper by P. H. Van Diest on the evidence bearing on the formation of ore deposits by lateral secretion.

19*c* —— Nickel. The occurrence, geological distribution and genesis of its ore deposits.

Colo. Sci. Soc., Proc., vol. iv, pp. 395–421.

Describes the chemical composition and occurrence of nickel in meteorites. Gives the chemical composition of the nickel ores, and discusses the occurrence of the arsenides, sulphides, and silicates of nickel, the genesis of the ore bodies and the distribution of the nickel ores.

20 **Ayres** (Edward F.). Plattnerite, and its occurrence near Mullan, Idaho; by Wm. S. Yeates. With crystallographic notes.

Am. Jour. Sci., 3d ser., vol. xliii, pp. 407–412.

B.

21 **Bäckström** (Helge). Causes of magmatic differentiation.

Jour. of Geol., vol. i, pp. 773–779.

Reviews the literature of the subject and discusses the causes and conditions under which magmatic differentiation takes place.

22 **Bailey** (E. H. S.) and **Case** (E. C.). On the composition of some Kansas building stones.

Kans. Acad. Sci., Trans., vol. xiii, p. 78 (½ p.).

Brief note giving results of chemical analyses.

23 **Bailey** (L. W.) and **McInnes** (W.). Report on portions of the Province of Quebec and adjoining areas in New Brunswick and Maine.

Canada Geol. Surv. Reports, vol. v, new series, part i, 1890–91, Report M, 27 pp.

Discusses the relations of the Cambrian and overlying Silurian rocks in this region, and states that fossils found in the latter indicate a Lower Helderberg horizon. Describes and illustrates by a colored sketch map the supposed arrangement of the Cambrian strata between Temiscouata Lake and Rivière du Loup.

24 **Bain** (Harry Foster). Distribution and relations of the St. Louis limestone in Mahaska County, Iowa.

Iowa Geol. Surv., vol. i, First Ann. Rept., 1892, pp. 173–179.

The Lower Coal Measures lie unconformably on the St. Louis limestone, the Kaskaskia beds to the south having been deposited in the interval. The Coal Measures filled up the valleys and the present drainage systems are independent of the old land surface.

25 **Bain** (F.). The Permian in Prince Edward Island.

Science, vol. xxi, pp. 132–133.

Describes the occurrence of Permian sandstones and shales and gives an account of their fossil contents.

26 **Baldwin** (S. Prentiss). Recent changes in the Muir glacier.

Am. Geol., vol. xi, pp. 366–375.

Discusses the methods of measuring the ice movement adopted by other observers and points out certain probable errors.

27 —— Muir glacier, Alaska.

Sci. Am., vol. lxvi, pp. 227–228.

Contains a general description of the glacier and an account of explorations in this region.

28 **Barbour** (Irwin H.). Notice of new gigantic fossils.

Science, vol. xix, pp. 99–100.

Describes some new fossils from northwestern Nebraska.

29 —— On a new order of gigantic fossils.

University of Nebraska, University Studies, vol. i, No. 4, July, 1892, p. 23, pl. 5.

Abstract: Jour. of Geol., vol. i, p. 421.

Describes a new order of Miocene fossils from Nebraska and proposes the following classification:

Order.	Family.	Genus.	Species.
.....	Daimonelicidæ	Diamonelix	circumaxilis.
			bispiralis.
		.....	anaxilis.
	.....		robusta.
			carinata.
		.....	.....
		.....	.....

30 **Barlow** (Alfred E.). On the nickel and copper deposits of Sudbury, Ontario.

Ottawa Nat., vol. v, pp. 51–71.

Abstract: Can. Rec. Sci., vol. v, pp. 68–69.

Gives an account of the mining operations of the district and a description of the geologic occurrence of the ore and of its mineralogic characters.

31 —— Relations of the Laurentian and Huronian rocks north of Lake Huron.

Geol. Soc. Am., Bull., vol. iv, pp. 313–332.

Abstract: Am. Nat., vol. xxvii, pp. 996–997.

Describes the general characteristics of Huronian and Laurentian rocks and their contact relations, and gives the results of the microscopic examination of the quartzites, gneisses, and schists. Summarizes the facts showing the eruptive nature of the Laurentian gneiss.

32 —— On the relations of the Laurentian and Huronian on the north side of Lake Huron.

Am. Jour. Sci., 3d ser., vol. xliv, pp. 236–239.

Discusses the relations of the two formations in this region.

33 **Barrett** (S. T.). Note on the paper in the November number of this journal on "A new Oriskany fauna in Columbia County, N. Y."

Am. Jour. Sci., 3d ser., vol. xlv, p. 72 (communicated).

Considers that this fauna extended to and reached a higher stage of development in Lower Devonian strata.

34 **Barton** (George H.). Bowlders formed in situ.

Tech. Quart., vol. v, pp. 401–403.

Refers to some granite bowlders of Montana and of eastern Massachusetts.

35 **Barus** (Carl). High temperature work in igneous fusion and ebullition, chiefly in relation to pressure.

U. S. Geol. Surv., Bull. No. 103, pp. 11–57.

Describes the apparatus used and gives results of experiments showing the pressure variations of certain high temperature (metallic) boiling points, the contraction of molten igneous rocks on passing from liquid to solid and the thermal capacity of igneous rocks, considered in its bearing on melting point and pressure.

36 —— Criticism of Mr. Fisher's remarks on rock fusion.

Am. Jour. Sci., 3d ser., vol. xlvi, pp. 140–141.

Discusses statements concerning the fusion points of certain rocks, in paper by O. Fisher, "Rigidity not to be relied upon in estimating the earth's age."

37 **Bascom** (Florence). The structure, origin, and nomenclature of the acid volcanic rocks of South Mountain.

Jour. of Geol., vol. i, pp. 813–832.

Describes the different structures which these acid rocks assume. Considers that these acid lava flows are similar to recent lavas found in the Yellowstone National Park and that the process of devitrifaction in these rocks is similar to that of crystallization in a fluid magma, except for the great length of time required. Reviews the nomenclature used by various authors in describing similar acid rocks.

37*a* **Baskerville** (Chas.), **Mitchell** (R. H.) and. An example of river adjustment.

See Mitchell (R. H.) and Baskerville (C.), 675.

38 **Baur** (G.). Notes on some little known American fossil tortoises.

Phila. Acad. Nat. Sci., Proc., 1893, part iii, pp. 411–430.

Reviews previous descriptions and classifications of some Cretaceous species of Wyoming and Colorado.

39 —— On the morphology of the skull in Mosasauridæ.

Jour. of Morph., vol. vii, pp. 1–22, pls. i–ii.

Reviews the literature on the characters of the skull of the Mosasauridæ, describes the skull of Platecarpus coryphæus Cope, found in the Cretaceous of Kansas, and includes remarks on the relations of the Mosasauridæ.

40 **Bayley** (William Shirley). Eleolite-syenite of Litchfield, Me., and Hawes's hornblende-syenite from Red Hill. N. H.

Geol. Soc. Am., Bull., vol iii, pp. 231–252.

Abstract: Am. Jour. Sci., 3d ser., vol. xliv, pp. 500–501.

Describes the megascopic and microscopic characters of the specimens and gives several chemical analyses. Concludes that of the two the New Hampshire rock is more nearly a normal eleolite-syenite.

41 —— Notes on the petrography and geology of the Akeley Lake region in northeastern Minnesota.

Minn. Geol. and Nat. Hist. Surv., 19th Ann. Rept., pp. 193–210.

States that the results of microscopic study of certain specimens mentioned in the 16th and 17th Minnesota Reports indicate that a different interpretation should be given them. Gives locality of specimens, with petrographic notes, a discussion of the character of specimens mentioned in each report, and a summary of results.

42 —— A fibrous intergrowth of augite and plagioclase, resembling a reaction rim, in a Minnesota gabbro.

Am. Jour. Sci., 3d ser., vol. xliii, pp. 515–520.

Gives the petrographic results of a study of the Keweenawan gabbros in northeastern Minnesota.

43 —— The classification and naming of igneous rocks.

Science, vol. xxi, pp. 87–88.

Reviews papers on "The origin of igneous rocks" and "The eruptive rocks of Electric Peak and Sepulchre Mountain, Yellowstone National Park," by J. P. Iddings, and discusses the principles of the classification of igneous rocks.

44 —— A fulgurite from Waterville, Me.

Am. Jour. Sci., 3d ser., vol. xliii, pp. 327–328.

45 —— Striated garnet from Buckfield, Me.

Am. Jour. Sci., 3d ser., vol. xliv, pp. 79–80 (communicated).

46 —— The basic massive rocks of the Lake Superior region.

Jour. of Geol., vol. i, pp. 433–456, 587–596, and 688–716.

Gives historical sketch of the gabbros and allied rocks, and discusses the question of the separation of the gabbros from the diabases. Reviews the literature concerning the basic massive rocks of the Lake Superior region and describes the position of the gabbros of northeastern Minnesota, with a petrographic description of the normal phase of gabbro.

47 **Bayley** (William Shirley). The eruptive and sedimentary rocks of Pigeon Point, Minn., and their contact phenomena.

U. S. Geol. Surv., Bull. No. 109, pp. 11–121, pls. i–xvi, figs. 1–15.

Describes the general distribution and relations of these rocks, the petrographic characters of the olivine-gabbro, diabase, red rock, contact rocks of olivine-gabbro and red rock, fragmental rocks, and the contact belt between the sedimentary and other rocks. Discusses the origin of the red rock.

48 —— Actinolite magnetite schists from the Mesabi iron range, in northeastern Minnesota.

Am. Jour. Sci., 3d ser., vol. xlvi, pp. 176–180.

Describes the petrographic characteristics of the rocks and remarks on their similarity to certain schists of the Penokee series.

49 **Beachler** (Charles S.). Keokuk group of the Mississippi Valley.

Am. Geol., vol. x, pp. 88–96.

Reviews the literature concerning this formation and gives a table of typical sections in Missouri, Indiana, Illinois, and Kentucky. Describes several exposures of the group.

50 —— Erosion of small basins in northwestern Indiana during the time preceding the Pleistocene period.

Am. Geol., vol. xii, pp. 51–53.

Describes the general features of a deep basin in Montgomery County and the character of the glacial deposits that were laid down in it.

51 **Beadle** (H. M.). The persistence of ores in lodes in depth. The Empire lode.

Eng. and Min. Jour., vol. lv, pp. 154–155.

Remarks on the evidences found in mines at Butte, Mont., concerning the formation of lodes in depth, with a description of the Empire lode.

52 **Becker** (George F.). Finite homogeneous strain, flow, and rupture of rocks.

Geol. Soc. Am., Bull., vol. iv, pp. 13–90.

Abstract: Am. Geol., vol. xi, p. 411 (¾ p.).

Discusses the general conditions of displacements, simple and compound strains, tangential strain, relation of stress and strain, and the viscosity, flow, and rupture of matter. Describes their geologic applications and reviews the theories of slaty cleavage.

53 —— Fisher's new hypothesis.

Am. Jour. Sci., 3d ser., vol. xlvi, pp. 137–139.

Refers to paper by O. Fisher "Rigidity not to be relied upon in estimating the earth's age," and discusses the bearing of oceanic tides on the theory of the viscosity or rigidity of the earth.

54 —— Quicksilver ore deposits.

U. S. Geol. Surv., Min. Res., 1892, pp. 139–168.

Describes the occurrence of mercurial deposits in the United States and foreign countries. Discusses the opinions of other writers concerning the origin of these deposits. Concludes that the usual association of minerals shows precipitation from solution which took place in thermal springs of volcanic origin to be the ordinary genetic process. The deposits occur as fissure veins, impregnations, and in zones of broken country rock. Tables of production.

55 **Beecher** (Charles E.). Devolopment of the Brachiopoda. Part II. Classification of the stages of growth and decline.

Am. Jour. Sci., 3d ser., vol. xliv, pp. 133–155.

Abstract: Am. Geol., vol. x, pp. 253–255.

Reviews the literature of the subject and discusses the observed stages of the growth of brachiopods and their limitations.

56 —— Notice of a new Lower Oriskany fauna in Columbia County, New York, with an annotated list of fossils by J. M. Clarke.

Am. Jour. Sci., 3d ser., vol. xliv, pp. 410–414.

Discusses the relations of the deposits of the region and concludes that the fauna are transitional.

57 —— Symmetrical cell development in the Favositidæ.

Conn. Acad. Arts Sci., Trans., vol. viii, part 2, pp. 215–219.

Describes the process of cell development and a symmetrical system of intermural cell multiplication observed in a specimen of Michelinia convexa D'Orbigny from the Corniferous limestone.

58 —— The development of a Paleozoic coral.

Conn. Acad. Arts Sci., Trans., vol. viii, part 2, pp. 207–214.

Describes the development of Pleurodictyum lenticulare. Concludes that its non-tabulate feature is without special consequence in considering the relations with other tabulate poriferous genera and that the development of mural pores is identical or homologous with the process of gemmation.

59 —— Larval forms of trilobites from the Lower Helderberg group.

Am. Jour. Sci., 3d ser., vol. xlvi, pp. 142–147.

Abstract: Am. Geol., vol. xii, pp. 334–335 (½ p.).

Describes and figures some larval forms of the trilobites, Phæthonides and Acidaspis, found in the Helderberg Mountains of New York and gives a classification of the stages of development.

60 —— A larval form of Triarthrus.

Am. Jour. Sci., 3d ser., vol. xlvi, pp. 378–379.

Describes an earlier stage in the development than that described by C. D. Walcott in 1879.

61 —— On the thoracic legs of Triarthrus.

Am. Jour. Sci., 3d ser., vol. xlvi, pp. 467–470.

Describes and illustrates specimens showing the presence and structure of thoracic legs in Triarthrus becki Green.

62 —— Revision of the families of Loup-bearing Brachiopoda: The development of Terebratalia obsoleta Dall.

Conn. Acad. Arts Sci., Trans., vol. ix, pp. 376–399.

Abstract: Am. Geol., vol. xii, pp. 188–190.

63 —— Ueber die Entwickelung der Brachiopoden.

Neues Jahrb. f. Min., etc., Band I, Heft 1, 1892, pp. 178–197.

Describes the general structure of brachiopods and the characteristics of several orders and gives a list of genera of each order.

64 —— and **Schuchert** (C.). Development of the brachial supports in Dielasma and Zygospira.

Wash. Biol. Soc., Proc., vol. viii, pp. 71–78, pl. x.

Describes the development of the loop in Dielasma turgida, as shown by a specimen from the Lower Carboniferous of Kentucky, the development of the brachial supports in Zygospira recurvirostra, and gives a statement of observations and correlations.

64*a* **Beecher** (Charles E.), **Dodge** (W. W.) and. On the occurrence of Upper Silurian strata near Penobscot Bay, Maine.

See Dodge (W. W.) and Beecher (C. E.), 253.

65 **Bell** (Robert). Report on the Sudbury mining district. With an appendix by Prof. George H. Williams.

Canada Geol. Surv. Reports, vol. v, new series, part i, 1890–91, Report F, 91 pp.

Abstract: Am. Geol., vol. ix, pp. 269–270.

Describes the Laurentian and Huronian rocks of the region, the occurrence of nickel and copper and their mineral association in these rocks, and discusses the origin of the ore bodies.

66 —— [Post-Glacial outlet to the Great Lakes.]

Geol. Soc. Am., Bull., vol. iv, pp. 425–427.

In discussion of paper by G. Frederick Wright "The supposed Post-Glacial outlet of the Great Lakes through Lake Nipissing and the Mattawa River."

67 **Benedict** (A. C.) Petroleum in Indiana.

Ind. Dept. Geol. and Nat. Hist., 17th Rept., 1891, pp. 306–325.

Gives a historical sketch of petroleum and an account of the extent of the Indiana oil field and sections of oil wells in various parts of the State.

67*a* —— **Elrod** (Moses W.) and. Geology of Wabash County [Indiana].

See Elrod (M. W.) and Benedict (A. C.), 291.

68 **Bierbauer** (Bruno). A check-list of the Paleozoic fossils of Wisconsin, Minnesota, Iowa, Dakota, and Nebraska.

Minn. Acad. Nat. Sci., Bull., vol. iii, No. 2, pp. 206–247.

Contains a table giving the names of the fossils and the state and formation in which they occur.

69 **Bigney** (A. J.). Preliminary notes on the geology of Dearborn County, Indiana.

Ind. Acad. Sci., Proc., 1891, pp. 66–67.

States that the principal formation is a blue limestone of Silurian age. Briefly describes the glacial drift exposures.

70 **Birkinbine** (John). [Occurrence of titaniferous iron ore.]

Am. Inst. Min. Engrs., Trans., vol. xxi, pp. 277–278.

In discussion of paper by H. B. C. Nitze, "The magnetic iron ores of Ashe County, N. C."

71 **Bishop** (Irving P.). Report on the development of the salt industry of central New York for the year 1891.

N. Y. State Mus., 45th Ann. Rept., pp. 53–61.

Gives several sections as shown by well borings at different localities.

72 **Blake** (William P.). Association of apatite with beds of magnetite.

Am. Inst. Min. Engrs., Trans., vol. xxi, pp. 159–160.

Mentions examples of such association in New York, Missouri, Utah, and New Jersey.

73 —— [Vein structure.]

Am. Inst. Min. Engrs., Trans., vol. xxi, p. 873.

In discussion of paper by Ernest Wiltsee, "Notes on the geology of the Half-Moon Mine, Pioche, Nev."

74 **Blake** (William P.). The mineral deposits of southwest Wisconsin.

Am. Geol., vol. xii, pp. 237–248.

Describes the geology of the region, the forms of the ore bodies and the character and structure of the blende deposits, with remarks on smithsonite, blende, barite, and marcasite ores.

75 —— The persistence of ores in lodes in depth.

Eng. and Min. Jour., vol. lv, p. 3.

Abstract: North of England Inst. of Min. and Mech. Engrs., Trans., vol. xlii, part v, p. 404 (⅛ p.).

Remarks on the independence of lode formation of any superficial phenomena and on the evidences of lateral secretion and vein filling in depth in the mines at Butte, Mont., and concludes that lode mineralization is deep seated and in a homogeneous rock formation may extend downward to and beyond the limit that mining operations can be conducted.

76 —— The progress of geological surveys in the State of Wisconsin. A review and bibliography.

Wis. Acad. Sci., Arts and Letters, vol ix, part i, pp. 225-231.

Reviews the literature of Wisconsin geology, particularly that relating to the lead and zinc deposits.

77 —— Age of the limestone strata of Deep Creek, Utah, and the occurrence of gold in the crystalline portions of the formation.

Am. Geol., vol. ix, pp. 47–48.

The limestone forms the ranges of hills and mountains and has been metamorphosed by the intrusion of granitic dikes. Its Carboniferous age is indicated by the contained fossils.

78 —— Relative abundance of gold in different geological formations.

Am. Geol., vol. ix, pp. 166–168.

Discusses the question as to the age of the chief gold-bearing formations in the United States.

79 **Blandy** (John F.). The persistence of ores in lodes in depth.

Eng. and Min. Jour., vol. lv, pp. 75–76.

Remarks on the evidences of lateral secretion and the comparatively limited depth to which mining has yet been carried.

80 —— Some notes on the geology of Arizona.

Eng. and Min. Jour., vol. lvi, pp. 473–474.

Describes the geology of portions of Arizona, with particular reference to the Triassic of the southern part of the Territory.

81 **Boyd** (Charles R.). The Indiana natural gas field.

Eng. and Min. Jour., vol. lv, pp. 440–441.

Describes the geologic structure of the region, illustrated by two cross sections.

82 —— The Wythe lead and zinc mines, Virginia.

Eng. and Min. Jour., vol. lv, pp. 561–562 and 586.

Gives a historical sketch of mining operations in this vicinity and describes the character of the ore and its manner of treatment.

83 **Boyle** (Cornelius Breckinridge). A catalogue and bibliography of North American Mesozoic Invertebrata.

U. S. Geol. Surv., Bull. No. 102, pp. 7–315.

Part I comprises an author's list of all publications that contain a description of species referred to the Mesozoic. Part II embraces a list of all names applied to Mesozoic species from North American rocks.

84 **Branner** (John C.). The mineral waters of Arkansas.

Ark. Geol. Surv., Rept. for 1891, vol. i, pp. 1–144.

Abstract: Am. Jour. Sci., 3d ser., vol. xlv, p. 73 (3 l.).

Describes the general characteristics and manner of occurrence of mineral waters in this State and gives many chemical analyses. Discusses the origin of their therapeutic qualities and the cause of some of the mineral waters being hot.

85 —— Observations upon the erosion in the hydrographic basin of the Arkansas River above Little Rock.

The Wilder Quarter-century Book, 1868–1893, pp. 325–337, Ithaca, N. Y., 1893.

Describes the methods of observation used in the study of the erosion of the Arkansas River basin in Arkansas, the physical and chemical character of the sediment, and gives analyses of the filtered river water and tables showing the relations of suspended to dissolved matter and the amount of material carried by the Arkansas River past Little Rock during the year 1887–88.

86 —— The coal fields of Arkansas.

U. S. Geol. Surv., Min. Res., 1892, pp. 303–306.

The coal fields lie in the drainage area of the Arkansas River. The coal-bearing rocks belong to true Coal Measure series, but the upper beds are probably Permo-Carboniferous, equivalent to those of Kansas and Nebraska. The lignites cover an area of 720 square miles, and are confined to the Tertiary area.

87 —— The supposed glaciation of Brazil.

Jour. of Geol., vol. i, pp. 753–772.

Reviews the theories on the glaciation of Brazil and the evidences on which they are based. Expresses the opinion that there are no phenomena of bowlders, gravels, clays, etc., that can be attributed to glacial agencies.

88 **Brewer** (William M.). The Warwhoop bauxite bank, Alabama.

Eng. and Min. Jour., vol. lv, p. 461.

Describes the body of bauxite occurring at this locality.

89 —— The brown ore deposit of Baker Hill, Ala.

Eng. and Min. Jour., vol. lv, pp. 77–78.

Gives a brief description of this ore body.

90 —— Some Alabama gold-mining districts.

Eng. and Min. Jour., vol. lv, p. 486.

Describes the occurrence of gold in parts of Cleburne and Randolph counties, Ala.

91 —— The Coosa coal field in Alabama.

Eng. and Min. Jour., vol. lvi, pp. 7–8.

Describes briefly the geologic structure of the region, with remarks on the occurrence of the coal.

92 **Broadhead** (G. C.). The Cambrian and Ozark series.

Am. Jour. Sci., 3d ser., vol. xlvi, pp. 57–60.

Refers to different papers on the Ozark series. Gives the section of the St. Louis well to a depth of 3,843 feet, indicating the succession of the limestone and sandstone beds and the author's general section in Madison County, Mo., and concludes that the evidence does not at present warrant a new classification.

93 **Broadhead** (G. C.). The correct succession of the Ozark series.

Am. Geol., vol. xi, pp. 260–268.

Reviews statements of F. L. Nason in paper "Iron ores of Missouri." Gives the lithologic characters of the beds in the Ozark region and discusses the evidence indicating the succession of the sandstone and magnesian limestone series.

94 —— A critical notice of the stratigraphy of the Missouri Paleozoic.

Am. Geol., vol. xii, pp. 74–89.

Describes the lithologic character of the strata resting on the Archean and the occurrence and geographic distribution of the magnesian limestones and the sandstones, and gives the vertical section of a well at St. Louis, to a depth of 3,843 feet, showing the presence of Quaternary, Carboniferous, Lower Silurian, and Upper Cambrian beds. Mentions the principal fossil forms found in the several subdivisions of the Paleozoic in Missouri.

96 **Brown** (S. B.). The Lower Coal Measures of Monongalia and Preston counties, W. Va.

Am. Geol., vol. ix, pp. 224–228, 2 figs.

Describes the topographic features of the region, and gives vertical sections at various localities which show the position and thickness of the several coal seams.

97 **Brumell** (H. Peareth H.). Notes on manganese in Canada.

Am. Geol., vol. x, pp. 80–88.

Describes the ore deposits at various localities and gives several chemical analyses of the ores. The crystalline ores are found in the Lower Carboniferous and the bog ore deposits in beds of recent formation.

98 —— Report on natural gas and petroleum in Ontario prior to 1891.

Canada Geol. Surv., Reports, vol. v, new series, part ii, 1890–91, Report Q, 94 pp.

Discusses the character of the hydrocarbons, with extracts from different publications bearing on the subject. Gives a record of various boring operations up to the close of 1890. Illustrated by four maps and sections. Appendix C is a bibliography of the subject.

99 —— Notes on the occurrence of petroleum in Gaspé, Quebec.

Geol. Soc. Am., Bull., vol. iv, pp. 241–244.

Abstract: Am. Geol., vol. xii, pp. 120–121 (⅛ p.).

The oil-bearing formation is found in sandstones of Lower Devonian or Upper Silurian age. Gives an account of recent work in this area.

100 —— On the geology of natural gas and petroleum in southwestern Ontario.

Geol. Soc. Am., Bull., vol. iv, pp. 225–240.

Abstract: Am. Geol., vol. xii, p. 120 (⅛ p.).

Describes the character of the Devonian, Silurian, and Cambro-Silurian strata of this region from the sections shown by several wells. Describes the occurrence of oil in the Corniferous and Medina formations and the occurrence of gas in Clinton, Medina, Niagara, Onondaga, and Trenton rocks.

101 **Bryson** (John). The glacial geology of Marthas Vineyard compared with that of Long Island.

Am. Geol., vol. xi, pp. 210–212 (correspondence).

Discusses the evidences indicating the character of the glacial phenomena on Long Island, and compares them with those of Marthas Vineyard as described in the report on the geology of Marthas Vineyard, by N. S. Shaler.

102 —— The drift mounds of Olympia and Long Island.

Am. Geol., vol. xii, pp. 127–129 (correspondence).

Describes the sand dunes of Long Island and compares them with the drift mounds of Olympia previously described by G. O. Rogers in the June number, 1893, of the American Geologist.

103 —— Origin of Peconic Bay and Shinnecock Hills, Long Island.

Am. Geol., vol. xii, pp. 402–403 (correspondence).

Considers their formation due, in part, at least, to subglacial streams.

104 **Buell** (Ira M.). Geology of the Waterloo quartzite area.

Wis. Acad. Sci. Arts and Letters, vol. ix, part ii, pp. 255–274.

Describes the structural features and lithologic characters of some Precambrian strata in southeastern Wisconsin.

C.

105 **Cadell** (Henry M.). The Yellowstone region and its geysers.

Scottish Geog. Mag., vol. viii, pp. 233–248.

Describes the topographic and geologic features of the region and the thermal springs and their deposits. Illustrated by a colored geologic sketch map and reproductions of photographs of the Mammoth Hot Springs and of the Giant Geyser.

106 **Call** (R. Ellsworth). Artesian wells in Iowa.

Science, vol. xix, pp. 310–311.

Abstract: Iowa Acad. Sci., Proc., vol. i, part ii, pp. 57–63.

Mentions the localities where artesian waters have been and may be found. Gives section of deep well at Cedar Rapids. Accompanied by sketch map.

107 —— The Tertiary silicified woods of eastern Arkansas.

Iowa Acad. Sci., Proc., vol. i, part ii, pp. 37-43.

Gives a list of localities where specimens are found and the vertical section of two most important localities. Discusses the evidence as to the cause of the silicification. Gives a description of the occurrence of silicified wood in Iowa.

107*a* —— **Keyes** (C. R.), and. On a Quaternary section 8 miles southeast of Des Moines, Iowa.

See Keyes (C. R.) and Call (R. E.), 531.

108 **Calvin** (Samuel). Notes on the difference between Acervularia profunda Hall and Acervularia davidsoni Edwards and Haime.

Am. Geol., vol. ix, pp. 355–358. Iowa Acad. Sci., Proc., vol. i, part ii, pp. 30–32.

States the difference between the two species.

109 **Calvin** (Samuel). The relation of the Cretaceous deposits of Iowa to the subdivisions of the Cretaceous proposed by Meek and Hayden.

Am. Geol., vol. xi, pp. 300–307. Iowa Acad. Sci., Proc., vol. i, part iii, pp. 7–12.

Describes the lithologic characters and gives a section of the Cretaceous deposits along the Big Sioux River. Refers to the descriptions of the Cretaceous of this region by Dr. C. A. White, and Meek and Hayden, and describes the processes of sedimentation and movements of elevation and subsidence during Cretaceous time.

110 —— On the structure and probable affinities of Cerionites dactyloides Owen.

Am. Geol., vol. xii, pp. 53–57. Iowa Acad. Sci., Proc., vol. i, part iii, pp. 13–15.

Refers to previous descriptions of Cerionites. Describes its fossil form and its probable characteristics while living.

111 —— Notes on some of the fossil corals described by David Dale Owen in his report of work done in the autumn of 1859, with observations on the Devonian species, Phillisastrea gigas of later authors.

Am. Geol., vol. xii, pp. 108–112.

Refers to species described by Owen and their identification and classification by later writers.

112 —— Notes on a collection of fossils from the Lower Magnesian limestone from northeastern Iowa.

Am. Geol., vol. x, pp. 144–148. Lab. Nat. Hist., State Univ. of Iowa, Bull., vol. ii, No. 2, pp. 189–193.

Refers to previous publications on the fossils of the Lower Magnesian series and describes Straparollus claytonensis, n. sp.; Straparollus pristiniformis, n. sp.; Raphistoma pepinense, Meek; Raphistoma multivolvatum, n. sp.; Raphistoma paucivolvatum, n. sp.; Murchisonia, sp.; Orthoceras primigenium Vanuxem; and Cyrtoceras luthei, n. sp., which belong either to the Gasteropoda or Cephalopoda, found in the cherty layers of the series.

113 —— Cretaceous deposits of Woodbury and Plymouth counties, Iowa, with observations on their economic uses.

Iowa Geol. Surv., vol. i, 1st Ann. Rept., 1892, pp. 147–169.

Describes the character and extent of the Woodbury shales, Niobrara chalks and clays of this region, giving sections shown at various localities.

114 —— Report on some fossils collected in the Northwest Territory, Canada, by naturalists from the University of Iowa.

Lab. Nat. Hist., State Univ. of Iowa, Bull., vol. ii, No. 2, pp. 163–165.

Describes Pentamerus decussatus Whiteaves, found in Upper Silurian strata near Lake Winnipeg.

115 —— Two unique spirifers from the Devonian strata of Iowa.

Lab. Nat. Hist., State Univ. of Iowa, Bull., vol. ii, No. 2, pp. 165–167.

Describes and figures Spirifera urbana Calvin and Spirifera macbridei Calvin.

116 **Calvin** (Samuel). A geological reconnoissance in Buchanan County, Iowa.

Lab. Nat. Hist., State Univ. of Iowa, Bull., vol. ii, No. 2, pp. 177–189.

Describes outcrops of Devonian strata in this region, mentions the fossils found in them, remarks on the irregularity in the line of outcrops and suggests it is due to an uplift at the close of the Niagara.

117 **Campbell** (John T.). Source of supply to lateral and medial glacial moraines.

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xl, pp. 255–256.

Discusses the origin of the debris of glaciers where no mountains or hillsides are present.

118 **Campbell** (Marius R.). [Correlation of coal seams of Big Stone Gap coal field of Virginia and Kentucky.]

Am. Inst. Min. Engrs., Trans., vol. xxi, pp. 1004–1005.

In discussion of paper by James M. Hodge, "The Big Stone Gap coal field."

119 —— Geology of the Big Stone Gap coal field of Virginia and Kentucky.

U. S. Geol. Surv., Bull. 111, pp. 13–106, pls. i–vi, figs. 1–3.

Describes the topographic features and geologic structure of the region. Reviews the previous work and gives a description of the lithologic characters and distribution of the different formations and of the coal outcrops, and discusses their correlation with coal seams in other parts of the Appalachian belt.

119*a* **Cannon** (George L., jr.). Notes on a discovery of radiolites, Austinensis roemer (?).

Colo. Sci. Soc., Proc., vol. iv, pp. 75–76.

Brief note on the occurrence of this fossil in the Niobrara Cretaceous.

119*b* —— Notes on the geology of Palmer Lake, Colo., and the Paleozoic exposures along the Front Range.

Colo. Sci. Soc., Proc., vol. iv, pp. 224–234, with map.

Describes the topography of the region, the granites, the occurrences of Paleozoic rocks, and the Jura-Trias, Cretaceous, Tertiary, and Quaternary beds which occur in this vicinity.

119*c* —— The geology of Denver and vicinity.

Colo. Sci. Soc., Proc., vol. iv, pp. 235–270.

Discusses the causes of the abscence of Paleozoic measures and describes the Triassic, Jurassic, Cretaceous, Tertiary, and Quaternary beds of the Denver Basin. Mentions some of the fossils found at different horizons.

119*d* **Cardeza** (J. T. M.), **Rand** (Theodore D.), **Jefferis** (Wm. W.), and. Mineral localities of Philadelphia and vicinity.

See Rand (T. D.), Jefferis (W. W.), and Cardeza (J. T. M), 769.

120 **Carlyle** (W. A.). Notes on a great silver camp.

Can. Rec. Sci., vol. v, pp. 403–412.

Describes the geology of the mining districts of Leadville and Aspen, Colo., and the occurrence and character of the ore bodies.

121 **Cary** (Austin). A study in foot structure.

Jour. of Morph., vol. vii, pp. 305–315, pl. xviii.

The paper is based on a study of a Perissodactyl from the Bridger Eocene Palæosyops and includes remarks on the theoretical applications.

122 **Case** (E. C.), **Bailey** (E. H. S.) and. On the composition of some Kansas building stones.

See Bailey (E. H. S.) and Case (E. C.), 22.

123 **Case** (William H.). The Bertha zinc mines at Bertha, Va.

Eng. and Min. Jour., vol. lvi, pp. 292–294.

Describes briefly the geological structure of the region and the occurrence and character of the ore, illustrated by map and cross sections.

124 **Chalmers** (Robert). Height of the Bay of Fundy coast in the Glacial period relative to sea level, as evidenced by marine fossils in the bowlder clay at St. John, New Brunswick.

Geol. Soc. Am., Bull., vol. iv, pp. 361–370.

Abstract: Am. Geol., vol. xi, pp. 176–177.

Describes the bowlder clay and the sections displayed at two localities and mentions the occurrence of certain fossil marine shells. Discusses the height of the land and the mode of deposition of the bowlder clay, the oscillations of the ice sheet, and the climatic conditions during the deposition of the Leda clay and Saxicava sands.

125 **Chaney** (L. W., jr.). Cryptozoon minnesotense in the Shakopie limestone at Northfield, Minn.

Minn. Acad. Nat. Sci., Bull., vol. iii, No. 2, pp. 280–284.

Describes the outcrops of this limestone in this locality and discusses the question of the organic origin of the Cryptozoon specimens found in them.

126 **Chamberlin** (T. C.). The horizon of drumlin, osar, and kame formation.

Jour. of Geol., vol. i, pp. 255–267.

Abstract: Am. Geol., vol. xii, pp. 122–123.

Defines the term englacial and describes the movements of englacial material from the bottom of the ice sheet to limited heights and the agents of its transportation. Describes the drumlin area of Wisconsin and the bowlder trains and bowlder belts of Ohio, Indiana, and Illinois. Concludes that the osars and kames of the latter region are basal material.

127 —— The diversity of the Glacial period.

Am. Jour. Sci., 3d ser., vol. xlv, pp. 171–200.

Reviews the different theories concerning the unity or diversity of the Glacial period, with special reference to and quotations from paper by G. F. Wright, "Unity of the Glacial period." Discusses the evidence as to the existence of the terminal moraine at certain points in New Jersey and the character of certain deposits in Delaware Valley and portions of Ohio. Refers to the gorge cutting of the Delaware and to concurrent erosion over the old drift surface, as proof of an interval between the earlier and later drift formation.

128 —— The altitude of the eastern and central portions of the United States during the Glacial period.

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xl, p. 250.

Gives a general summary of the author's conclusions.

129 **Chamberlin** (T. C.). The nature of the englacial drift of the Mississippi basin.

Jour. of Geol., vol. i, pp. 47–60.

Discusses the cause of the movement of basal material upward into the body of a glacier. Describes the course of several bowlder belts through Indiana, their relation to terminal moraines, and the characters that distinguish them from the average bowlders of the till, and concludes that they represent an example of englacial and superglacial transportation.

130 —— Some additional evidences bearing on the interval between the glacial epochs.

Wis. Acad. Sci. Arts and Letters, vol. viii, pp. 82–86.

The evidences point to the conclusion that toward the close of the earlier glacial epoch the altitude of the continent was low, in the interval it became higher, and during the later epoch its valley deposits were carried down the trenches formed during the interval.

131 —— [Glacial succession in the United States.]

Abstract: Am. Geol., vol. xii, pp. 227–228.

Paper read before the World's Congress on Geology.

132 —— and **Salisbury** (R. D.). On the relationship of the Pleistocene to the Prepleistocene formations of the Mississippi basin south of the limit of glaciation.

Abstract: Am. Nat., vol. xxvi, pp. 48–49.

Paper described in Record for 1891.

133 **Chapman** (E. J.). Note on the Belmont gold veins of Peterboro County, Ontario.

Can. Roy. Soc., Trans., vol. xi, sect. iv, pp. 51–52.

Describes the country rock of the region and the vein phenomena of the ore bodies.

134 —— On the corals and coralliform types of Paleozoic strata.

Can. Roy. Soc., Trans., vol. x, sect. iv, pp. 39–48.

In a tabular synopsis classifies the cœlenterates into five subdivisions.

135 **Chapman** (Henry C.). Note on the geology of Mount Desert Island.

Phila. Acad. Nat. Sci., Proc., 1892, part iii, p. 350.

Brief description of the geology of the island.

135*a*. **Charlton** (Thomas). [Occurrence of nickel.]

Colo. Sci. Soc., Proc., vol. iv, pp. 420–421.

In discussion of paper by Philip Argall on "Nickel, the occurrence, geological distribution, and genesis of its ores," describes the occurrence of nickel in the Gem Mine, Fremont County, Colo.

136 **Chatard** (Thomas M.). Phosphate chemistry as it concerns the miner.

Am. Inst. Min. Engrs., Trans., vol. xxi, pp. 160–175.

Discusses some problems of phosphate analysis and describes the processes to be followed in making a chemical analysis of a natural phosphate.

137 **Church** (John A.). The cause of faulting.

Am. Inst. Min. Engrs., Trans., vol. xxi, pp. 782–792.

Discusses the different explanations of the cause of faulting and their insufficiency to account for local faults of moderate extent. Considers that fissuring of rocks by compression may occur without dislocation and that, in the movement of rocks, both walls participate in the movement and the fault becomes shortened.

138 —— Faulting in veins.

Eng. and Min. Jour., vol. liii, pp. 469–470, 613–614, and 637–638 (correspondence).

Reviews statement of Albert Williams, jr., concerning the occurrence of veins on the lines of fault fissures and describes the characteristics of vein formations.

138*a*—— [Vein structure.]

Am. Inst. Min. Engrs., Trans., vol. xxi, pp. 871–872.

In discussion of paper by Ernest Wiltsee, "Notes on the geology of the Half-Moon Mine, Pioche, Nev."

139 **Clark** (William Bullock). The Mesozoic Echinodermata of the United States.

U. S. Geol. Surv., Bull. No. 97, pp. 13–101, pls. i–1.

Abstracts: Am. Nat., vol. xxvii, p. 1079 (⅓ p.); Johns Hopkins Univ. Circ., vol. xii, pp. 51–52.

Gives a bibliography of North American Echinodermata, a description of the determining characteristics of the different species, and tables showing their geologic range in North America and the specific names employed by writers on the Mesozoic Echinodermata.

140 —— A preliminary report on the Cretaceous and Tertiary formations of New Jersey.

N. J. Geol. Surv., Ann. Rept. 1892, pp. 169–239, pls. iv–vi.

Reviews the literature on the deposits of this region. Describes the topographic features and the lithologic and structural characters of the Cretaceous and Tertiary formations. Gives lists of fossils found in the several marl beds and discusses the origin, character, and manner of occurrence of glauconite.

141 —— The Eocene of the United States.

Johns Hopkins Univ. Circ., vol. xii, pp. 50–51.

Describes the characters of the Eocene deposits of the Atlantic Coast, Gulf Coast, Pacific Coast, and interior regions.

142 —— Correlation Papers. Eocene.

U. S. Geol. Surv., Bull. No. 83, p. 159, pls. i–ii.

Abstracts: Am. Geol., vol. xii, p. 379 (⅜ p.); Am. Nat., vol. xxvi, pp. 330–332.

Describes the stratigraphy of the Eocene beds of the Atlantic Coast, Gulf States, and the Pacific Coast region, and gives lists of their contained fossils and discusses their correlation. Includes a bibliography of the papers on the Eocene of each of these regions.

142*a*—— **Williams** (G. H.) and. Reports on short excursions made by the geological department of the University during the autumn of 1891.

See Williams (G. H.) and Clark (W. B.), 1049.

143 **Clark** (William Bullock), **Williams** (G. H.) and. [Geology of Maryland.]

Maryland, its Resources, Industries, and Institutions, pp. 55–88, Baltimore, 1893.

Abstract: Am. Geol., vol. xii, pp. 396–398.

Includes a general description of the various geologic formations of Maryland.

144 **Clarke** (F. W.). Note on the constitution of ptilolite and mordenite.

Am. Jour. Sci., 3d ser., vol. xliv, pp. 101–102.

145 **Clarke** (John M.). Notes on the genus Acidaspis; note on Coronura aspectans Conrad (sp.), the Asaphas diurus Green; observations on the Terataspis grandis Hall, the largest known trilobite.

N. Y. State Geologist, Tenth Ann. Rept., 1891.

Abstracts: Am. Jour. Sci., 3d ser., vol. xliii, pp. 158–159; Am. Geol., vol. ix, pp. 202–203.

146 —— On the structure of the carapace in the Devonian crustacean Rhinocaris, and the relation of the genus Mesothyra and the Phyllocarida.

Am. Nat., vol. xxvii, pp. 793–801.

Describes the structural characters of the typical species of Rhinocaris and compares them with those of Mesothyra and Phyllocarida.

147 —— The protoconch of Orthoceras.

Am. Geol., vol. xii, pp. 112–115.

Reviews the descriptions of the structure of the protoconch of the nautiloid Orthoceras, by Professor Hyatt and Dr. Branco, and describes remains from the Genesee shales of New York.

148 —— The discovery of Clymenia in the fauna of the Intumescens zone (Naples beds) of western New York, and its geological significance.

Am. Jour. Sci., 3d ser., vol. xliii, pp. 57–63.

Describes and gives drawings of newly discovered and very perfect specimens of Clymenia from the lower part of the Upper Devonian, which has hitherto been considered an horizon marker for the uppermost Devonian only, especially in Europe.

See Hall, 383 and 384.

149 —— On Cordania, a proposed new genus of Trilobites.

N. Y. State Mus., 45th Ann. Rept., pp. 440–443.

Discusses the classification of certain species from the Helderberg and Hamilton groups.

150 **Claypole** (E. W.). A new gigantic placoderm from Ohio.

Am. Geol., vol. x, pp. 1–4.

Describes the lower jaw and teeth of this species found in the Cleveland shale near Berea, Ohio.

151 —— The head of Dinichthys.

Am. Geol., vol. x, pp. 199–207.

Describes particularly the plates and illustrates the skull of Dinichthys in three figures.

152 **Claypole** (E. W.). The tin islands of the Northwest.

Am. Geol., vol. ix, pp. 228–236.

Describes the structural characteristics of the igneous and sedimentary rocks that form the Black Hills, and the movements of elevation and subsidence that have occurred in the region. The cassiterite is confined to the granite veins, and is very finely and irregularly disseminated.

153 —— A new Coccostean-coccosteus Cuyahogæ.

Am. Geol., vol. xi, pp. 167–171.

Refers to previous descriptions of species of Coccosteus, and describes a new species from the Cleveland shale of Ohio.

154 —— The cladodont sharks of the Cleveland shale.

Am. Geol., vol. xi, pp. 325–331.

Abstract: Am. Nat., vol. xxvii, p. 1083 (⅛ p.).

Refers to the description of Cladodont fishes by Dr. Newberry, with remarks on the classification. Describes: Cladodus kepleri, Cladodus clarki, Cladodus sinuatus, Cladodus rivi-petrosi, Monocladodus clarki, and Monocladodus pinnatus.

155 —— The three great fossil placoderms of Ohio.

Am. Geol., vol. xii, pp. 89–99.

Describes the general characteristics of the fossils found in the Cleveland and Huron shales, with special reference to placoderms.

156 ——On three new species of Dinichthys.

Am. Geol., vol. xii, pp. 275–279.

Describes three new species, D. lincolni, D. clarki, and D. gracilis, from parts of the organs of the mouth, one from the Marcellus shale and the others from the Cleveland shale.

157 —— On a deep Preglacial river bed near Akron, Ohio.

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xl, p. 259.

The evidence of the existence of the deep river bed is afforded by data obtained in sinking a deep well in the center of a pre-Glacial valley.

158 —— On the structure of the American pteraspidian, Palæaspis (Claypole), with remarks on the family.

Geol. Soc. Quart. Jour., vol. xlviii, pp. 542–561.

Gives a statement concerning the discovery of pteraspidian fishes in the Upper Silurian of Pennsylvania. Reviews some of the previous descriptions and classifications of these fossils. In a figure gives an attempted restoration of P. Americana and also gives an amended definition of Palæaspis.

159 —— A deep boring in the Pleistocene near Akron, Ohio.

Geol. Soc. Am., Bull., vol. iii, pp. 150–151.

Describes the surface geology of the region and the section exhibited by the boring.

160 —— The Upper Devonian fishes of Ohio.

Geol. Mag., dec. iii, vol. x, pp. 443–448.

Describes a deposit of shale which represents a transition period between the Carboniferous and Devonian, with remarks on some of the fishes found in the shale.

161 —— An episode in the history of the Cuyahoga River.

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xli, p. 176 (9 l.).

162 **Cobb** (Collier). A recapture from a river pirate.

Science, vol. xxii, p. 195 (correspondence).

Describes phenomena caused by changes in the drainage of the Jackson River, Virginia.

163 **Cole** (A. H.). Palæaster eucharis Hall.

Geol. Soc. Am., Bull., vol. iii, pp. 512–514.

Abstract: Am. Geol., vol. xi, p. 120 (5 l.).

Quotes the description of Dr. Hall of his type specimen, and states wherein the present specimen differs from it.

164 **Coleman** (A. P.). Some Laurentian rocks of the Thousand Islands.

Can. Rec. Sci., vol. v, pp. 127–131.

Describes the Laurentian granites, gneisses, and quartzites of which these islands are composed.

165 ——The rocks of Clear Lake, near Sudbury.

Can. Rec. Sci., vol. v, pp. 343–346.

Describes the petrographic characters of gabbro, micropegmatite, and other rocks from a portion of the Sudbury district not heretofore examined, and compares them with collections from other portions of this district.

166 **Coman** (C. W.). Geological work in southern New Jersey.

N. J. Geol. Surv., Rept. for 1891, pp. 111–256.

Gives a general description of the surface deposits of the region and its artesian wells, with numerous sections as shown by the borings.

167 **Comstock** (Theodore B.). A preliminary report on parts of counties Menard, Concho, Tom Green, Sutton, Schleicher, Crockett, Valverde, Kinney, Maverick, Uvalde, Edwards, Bandera, Kerr, and Gillespie, Tex.

Texas Geol. Surv., 2d Rept. of Prog., 1891, pp. 43–54.

Describes the Lower Cretaceous and Jurassic strata of this region, its topographic features, artesian water, and mineral resources.

168 —— Valuable experiments in vein formation.

Science, vol. xix, p. 214.

Refers to some experiments made by Prof. von Streeruwitz and the conclusions drawn therefrom.

169 **Cooper** (A. S.) The genesis of petroleum and asphalt in California.

Sci. Amer. Suppl., vol. xxxvi, pp. 14738–14740.

Gives a detailed description of some deposits near Santa Barbara, with topographic map of the region and cross section, and includes brief remarks concerning similar deposits in other portions of California.

170 **Cope** (E. D.). On the characteristics of some Paleozoic fishes.

U. S. Nat. Mus., Proc., vol. xiv, pp. 447–463, pls. xxviii–xxxiii.

Abstract: Am. Geol., vol. ix, pp. 263–264.

Describes new species from the Permian of Nebraska and Texas and the characters of other fossils from the Paleozoic.

171 —— On the cranial characters of Equus excelsus.

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xl, p. 285.

Distinguishes the general characters of the quagga from those of the horse.

172 **Cope** (E. D.). On a new horizon of fossil fishes.

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xl, p. 285.

Mentions five species of fish from South Dakota, which differ in species, and some of them as to genus, from any hitherto known. They are Cenozoic in age, but it is not yet known to which division they belong.

173 —— The Cenozoic beds of the Staked Plains of Texas.

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xli, p. 177 (4 l).

174 —— On a new form of Marsupialia from the Laramie formation.

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xli, p. 177 (5 l).

175 —— A contribution to a knowledge of the fauna of the Blanco beds of Texas.

Phila. Acad. Nat. Sci., Proc., 1892, part ii, pp. 226-229.

Describes Testudo turgida Cope, Testudo pertenuis, sp. nov.; Mastodon successor, sp. nov.; Pliauchenia obtained from these beds, and concludes that the fauna of the Blanco beds are intermediate between the Loup Fork and Equus beds. The fauna represent species of large size, including mastodons, camels, and horses.

176 —— A new extinct species of Cyprinidæ.

Phila. Acad. Nat. Sci., Proc., 1893, part i, pp. 19–20.

Describes a new species from Illinois which is probably not earlier than the Pliocene.

177 —— On Tiaporus, a new genus of Teiidæ.

Am. Phil. Soc., Proc., vol. xxx, No. 137, pp. 132–133.

178 —— The osteology of the Lacertilia.

Am. Phil. Soc., Proc., vol. xxx, No. 138, pp. 185–221.

Especial reference is made to the necessities of the paleontology of the order and to the Nearctic fauna.

179 —— On some new and little known Paleozoic vertebrates.

Am. Phil. Soc., Proc., vol. xxx, No. 138, pp. 221–229.

Describes Holonema horrida, sp. nov.; Holonema rugosa Clayp.; Bothriolepis minor Newb.; Ganorhynchus oblongus, sp. nov.; Coccosteus macromus, sp. nov.; Megalichthys macropomus, sp. nov.; (?) Holoptychius filosus, sp. nov.· found in Chemung and Catskill beds of northern Pennsylvania.

180 —— On the skull of the dinosaurian Lælaps incrassatus Cope.

Am. Phil. Soc., Proc., vol. xxx, No. 138, pp. 240–245.

Describes two crania from the Laramie of Red Deer River, Canada.

181 —— On the genus Tomiopsis.

Am. Phil. Soc., Proc., vol. xxxi, No. 142, pp. 317–318.

Describes the characteristics of a tooth of this genus found in a bed of Neocene age in western Texas.

182 —— Report on paleontology of the vertebrata.

Texas Geol. Surv., 3d Ann. Rept., 1891, pp. 251–259; Am. Phil. Soc., Proc., vol. xxx, No. 137, pp. 123–131.

Refers to certain species found in the Fayette formation which indicate that it occupies the summit of the Tertiary. Describes Equus simplicidens, n. sp.; Creccoides osbornii Shufeldt, n. gen. et sp.; Testudo turgida, n. sp.; a Mesozoic Pycnodont, Microdus dumbelii, n. sp.; and Episcoposaurus haplocerus, n. sp., from the Triassic or Dockum beds.

183 **Cope** (E. D.). A preliminary report on the vertebrate paleontology of the Llano Estacado.

Texas Geol. Surv., 4th Ann. Rept., 1892, pp. 11–87, pls. i–xxiii.

Describes vertebrate remains found in the Dockum beds of the Trias, in the Loup Fork and Blanco beds of the Miocene, and in the Equus beds of the Pliocene.

184 **Cox** (Charles F.). On recently discovered deposits of diatomaceous earth in the Adirondacks.

N. Y. Acad. Sci., Trans., vol. xii, pp. 219–220.

Describes the deposits found in Herkimer County and gives a brief statement concerning the fossils found in them.

185 **Cragin** (F. W.). Observations on llama remains from Colorado and Kansas.

Am. Geol., vol. ix, pp. 257–260.

Describes some remains from volcanic ash beds of Kansas and from the Denver loess.

186 —— A contribution to the invertebrate paleontology of the Texas Cretaceous.

Texas Geol. Surv., 4th Ann. Rept., 1892, pp. 141–246, pls. xxiv–xlvi.

Description of genera and species of Cœlenterata, Echinodermata, Molluscoida, Mollusca, Gasteropoda and Cephalopoda from the Cretaceous series of Texas.

187 **Crane** (Agnes). The generic evolution of the Paleozoic brachiopoda.

Science, vol. xxi, pp. 72–74.

Am. Geol., vol. xi, pp. 400–406.

Refers to the work of different authors on the Paleozoic brachiopoda, with special reference to the work of Prof. James Hall and his recent memoirs "An introduction to the study of the genera of Paleozoic brachiopoda."

188 **Crawford** (J.). The geology of Nicaragua.

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xl, pp. 261–270.

Describes the general geologic features. Concludes that there exists an Archean core upon which later rocks have been deposited unconformably, the latter being separated from each other by nonconformities. A glacial epoch existed synchronous with the same epoch in North America.

189 —— The peninsula and volcano of Cosigüina.

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xl, pp. 270–274.

Describes the topographic features and orographic movements that have taken place in the region.

190 —— Recent discoveries in northeastern Nicaragua: granite hills, moutonnéd ridges and gold-containing lodes or reefs, and leads or placer mines.

Science, vol. xxii, pp. 269–272.

Describes the geology of the region and its mineral deposits.

191 —— Notes on earthquakes in Nicaragua, February 6, 1892.

Am. Geol., vol. x, pp. 115–118.

Describes the series of vibrations and oscillations which took place.

192 **Crook** (Alja Robinson). Ueber einige fossile Knochenfische aus der Mittleren Kreide von Kansas.

Palaeontographica, Band xxxix, 1892, pp. 107-124, pls. xv-xviii.

Describes some fossil fishes from the Cretaceous beds of Kansas, Protosphyrænidæ S. Woodward, Ichthyodectes anaides Cope, Ichthyodectes polymicrodus Cope, Portheus Cope.

193 **Crosby** (William O.). Geology of the Boston Basin.

Boston Soc. Nat. Hist., Occasional Papers IV, vol. i, part i, Nantasket and Cohasset, pp. 1–177.

Describes the older or granitic rocks and includes a description of the newer eruptive rocks of the region and the diabase and porphyrite dikes, by G. P. Merrill. Gives an account of the surface geology and its glacial deposits and phenomena.

194 —— Geology of Hingham, Mass.

Abstract: Boston Soc. Nat. Hist., Proc., vol. xxv, pp. 499–512.

Describes the geology of the region, gives a general vertical section of the strata and discusses the evidences of their geologic age.

195 —— The origin of parallel and intersecting joints.

Am. Geol., vol. xii, pp. 368–375.

Abstract: Tech. Quart., vol. vi, pp. 230–236.

Reviews the torsion theory of joints and the character and results of Daubrée's experiments.

196 **Cross** (Whitman). Igneous rocks from the coal and iron regions of Coahuila and Nueva Leon, Mexico, collected by R. T. Hill.

Am. Jour. Sci., 3d ser., vol. xlv, pp. 119-120.

Describes the microscopic characters of specimens of basalt, diorite, hornblende-porphyrite, and augite-diorite; the former are considered deep-seated eruptives and the latter equivalent to the diorite, but from smaller masses and probably consolidated nearer the surface.

197 —— Post-Laramie deposits of Colorado.

Am. Jour. Sci., 3d ser., vol. xliv, pp. 19–42.

Abstracts: Am. Geol., vol. x, pp. 256–257 (½ p.); Am. Nat., vol. xxvii, p. 471 (½ p.).

Describes the deposits occurring in different parts of the State and concludes that, in Colorado, the deposition of the conformable series of the Cretaceous ended with the coal-bearing Laramie, as the result of a long-continued continental elevation in this region, and when it began again the deposits were laid down in lakes or small seas. Discusses the fossil evidences bearing on the geologic age of the formation.

197*a* —— The Post-Laramie beds of Middle Park, Colorado.

Colo. Sci. Soc., Proc., vol. iv, pp. 192–213.

Gives historical sketch of the work done and reviews the literature on this region. Describes the character of the beds, called doleritic breccia by Marvine, and the constitution of the lignitic beds. Discusses the stratigraphic relations and reviews the evidence of the fossil flora as to the age of the Middle Park beds.

197*b* —— On a series of peculiar schists near Salida, Colo.

Colo. Sci. Soc., Proc., vol. iv, pp. 286–293.

Reviews the representation of the geology of the region on the Hayden Atlas, and indicates the general character of the necessary corrections. Describes the stratigraphy and general character of the schists, and discusses their origin and relationships.

198 **Cross** (Whitman) and **Eakins** (L. G.). A new occurrence of ptilolite.

Am. Jour. Sci., 3d ser., vol. xliv, pp. 96–101.

Abstract: Am. Nat., vol. xxvii, p. 43 (⅓ p.).

Describes the chemical and mineralogic characteristics of the rock in which ptilolite occurs.

199 **Culver** (G. E.). Notes on a little known region in northwestern Montana.

Wis. Acad. Sci. Arts and Letters, Proc., vol. viii, pp. 187–205.

Abstract: Am. Geol., vol. xi, pp. 412–413 (⅓ p.).

Describes the general geographic features of the region, the structure of the plains and mountains and the strata exposed, with petrographic notes on the igneous rocks, chiefly diabase. Describes the character of the existing glaciers and the general features of former glaciers. Discusses the origin of the ice tongues of the eastern slope of the Rocky Mountains.

200 —— and **Hobbs** (Wm. H.). On a new occurrence of olivine diabase in Minnehaha County, S. Dak.

Wis. Acad. Sci. Arts and Letters, Proc., vol. viii, pp. 206–210.

Describes the decomposition of the rock and states that considerable erosion has taken place. Gives petrographic notes on thin sections examined.

201 **Cummins** (A.). Geology of the natural gas fields about Pittsburg.

Eng. and Min. Jour., vol. liv, pp. 106–107.

Describes the structural features of the region and the character of the strata through which the borings pass. Gives information concerning the pressure of gas and its diminution in the wells.

202 **Cummins** (W. F.). Report for 1891.

Texas Geol. Surv., 2d Rept. of Prog., 1891, pp. 27–42.

Describes the topographic and geologic features of the Staked Plains region, its artesian water supply and mineral resources.

203 —— Report on the geography, topography, and geology of the Llano Estacado or Staked Plains, with notes on the geology of the country west of the plains.

Texas Geol. Surv., 3d Ann. Rept., 1891, pp. 129–223.

Describes the topographic features of the region and the Quaternary, Tertiary, Cretaceous, and Triassic formations, and includes notes on the same formations and the Carboniferous occurring in the country west of the plains.

204 —— Notes on the geology of northwest Texas.

Texas Geol. Surv., 4th Ann. Rept., 1892, pp. 179–238.

Describes the general geology of the region and gives a table containing a list of Pleistocene and fresh-water shells of the region. Remarks on the removal of the entire Cretaceous, comprising 10,000 feet of strata and the absence of the Tertiary below the Loup Fork beds over the entire area. Gives sections of the Tule, Blanco, and Loup Fork beds, and a description of the Permian of Texas and other parts of the United States and Europe, and of the occurrence of copper ore in these beds.

205 **Cummins** (W. F.). Tucumcari Mountain.

Am. Geol., vol. xi, pp. 375–283.

Reviews the previous publications concerning this region and refers to criticisms on the author's report in the Third Annual Report of the Texas Geological Survey, by Jules Marcou.

206 —— The Texas meteorites.

Texas Acad. Sci., Trans., vol. i, pp. 14–18.

Gives a historical sketch of Texas meteorites.

207 —— Geology of Tucumcari, New Mexico.

Science, vol. xxi, pp. 282–283.

Gives a list of fossils found at this locality and concludes that the strata are Triassic, Cretaceous, and Tertiary. Refers to certain statements concerning the geology of the region.

208 —— **Dumble** (E. T.) and. The Kent section and Gryphæa tucumcarii Marcou.

Am. Geol., vol. xii. pp. 309–314.

Gives the section occurring at this locality in western Texas, with a list of fossils found, representing three divisions of the Cretaceous.

209 **Cushing** (H. P.). The movement of Muir glacier.

Am. Geol., vol. xi, pp. 276–278 (correspondence).

Refers to criticisms by G. F. Wright.

210 —— Notes on the geology of the vicinity of Muir glacier.

Nat. Geog. Mag., vol. iv, pp. 56–62.

Describes the strata, consisting of argillites and limestones, in this region. A few fossils found indicate their Paleozoic age. The older eruptive rocks are diorites, which, with the sedimentaries, are cut by small dikes of later date.

D.

211 **Dale** (T. Nelson). On the structure and age of the Stockbridge limestone in the Vermont valley.

Abstract: Geol. Soc. Am., Bull., vol. iii, pp. 514–519.

The main feature of the region is a complex anticlinal of gneiss and Cambrian quartzite and schist, flanked by Cambrian limestone and Lower Silurian limestone. Owing to faults at some points the base of the Stockbridge limestone, with its Cambrian fauna, is exposed; in others, the top with Lower Silurian fauna. Accompanied by sketch map.

212 —— The Rensselaer grit plateau in New York.

U. S. Geol. Surv., 13th Ann. Rept., part ii, pp. 297–340, pls. xcvii–ci, figs. 18–41.

Describes the petrographic characters of the Cambrian and Silurian rocks in this region and mentions the fossils found in them. Discusses the geologic structure and relations of the formations and includes a table exhibiting the stratigraphic, petrographic, and paleontologic results obtained.

213 —— On plicated cleavage-foliation.

Am. Jour. Sci., 3d ser., vol. xliii, pp. 317–319.

Describes an occurrence of this structure at West Rutland, Vt.

214 **Dall** (William Healey). Grand Gulf formation.

Science, vol. xx, pp. 164–165 and 319–320.

Describes the conditions of sedimentation during the Grand Gulf period and gives the names of fossils found in some of the deposits.

215 —— Tertiary mollusks of Florida.

Wagner Free Inst. of Sci., Trans., vol. iii, parts i and ii, 1892, pp. 1–446, pls. 1–22.

Abstract: Am. Jour. Sci., 3d ser., vol. xlv, p. 441 (⅓ p.).

Reviews the opinions of other writers on the Tertiary beds and their fauna. Describes the processes of deposition in the Southeastern States during Tertiary time and locates and describes many species found in these beds.

216 —— and **Harris** (Gilbert Dennison). Correlation papers. Neocene.

U. S. Geol. Surv., Bull. No. 84, 349 pp., pls. i–iii, figs. 1–43.

Abstracts: Am. Jour. Sci., 3d ser., vol. xlv, pp. 351–354; Am. Geol., vol. xii, pp. 399–402.

Gives a summary of the knowledge of the Neocene deposits of the Atlantic and Gulf coasts, of the Pacific Coast and Canada, and of the supposed Neocene of the interior of the United States, and includes a list of names applied to Cenozoic beds.

217 **Dana** (James D.). On subdivisions in Archean history. Part I.

Am. Jour. Sci., 3d ser., vol. xliii, pp. 455–462.

Discusses the subdivisions of Archean time as based on—1, kinds of rocks; 2, stratification; and 3, physical and biological conditions.

218 —— Additional observations on the Jura-Trias trap of the New Haven region.

Am. Jour. Sci., 3d ser., vol. xliv, pp. 165–169.

Describes the outcrop of a trap dike in this region and states that the outflow was laccolithic. Discusses two hypotheses concerning the origin of the trap belts.

219 —— New England and the Upper Mississippi basin in the Glacial period.

Am. Jour. Sci., 3d ser., vol. xlvi, pp. 327–330.

Abstract: Jour. of Geol., vol. i, pp. 847–849.

Considers that the cause of divergence of opinion concerning the unity of the glacial period is due to the different conditions in the eastern and western portions of the glacial area consequent on meteorological differences in the two regions. Describes the general conditions existing during the glacial period.

220 **Darton** (Nelson Horatio). Fossils in the "Archean" rocks of central piedmont Virginia.

Am. Jour. Sci., 3d ser., vol. xliv, pp. 50–52.

Brief description of the occurrence of roofing slates in the piedmont plain west of Richmond, in which fossils, determined by C. D. Walcott as of Lower Silurian age, have been found.

221 **Darton** (Nelson Horatio). The stratigraphic relations of the Oneonta and Chemung formations in eastern-central New York.

Am. Jour. Sci., 3d ser., vol. xlv, pp. 203–209.

Abstract: Am. Nat., vol. xxvii, p. 558 (⅛ p.).

Describes the geographic distribution of the two formations in this region and the relations of the beds, illustrated by cross section and columnar sections. Describes their lithologic characters and discusses the use of the term "Catskill."

222 —— The Magothy formation of northeastern Maryland.

Am. Jour. Sci., 3d ser., vol. xlv, pp. 407–419.

Describes the general relations of the Costal Plain formations, including a geologic map of the Magothy and associated formations in northeastern Maryland and a discussion of the distribution and lithologic character of the Magothy strata in this region.

223 —— On fossils in the Lafayette formation in Virginia.

Am. Geol., vol. ix, pp. 181–183.

The fossils were found at the base of the formation and are so poorly preserved as to be difficult of identification, and, on account of their water-worn condition, it is possible they may have been derived from the underlying Chesapeake beds.

224 —— Record of North American geology for 1891.

U. S. Geol. Surv., Bull. No. 99, pp. 6–73.

Gives a list of papers on North American geology, with notes descriptive of contents and index references.

225 —— Notes on the stratigraphy of a portion of central Appalachian Virginia.

Am. Geol., vol. x, pp. 10–18.

Refers to the nomenclature of the formations in this region used by other writers. Describes the Silurian, Devonian and Carboniferous strata and compares them with strata of the same age in New York and Pennsylvania.

226 —— On two overthrusts in eastern New York.

Geol. Soc. Am., Bull., vol. iv, pp. 436–439.

Describes two overthrusts of Silurian rocks in the Shawangunk Mountain, illustrated by three cross sections.

227 **Davidson** (Walter B. M.). Florida phosphates: Origin of the bowlder phosphates of the Withlacoochee River district.

Eng. and Min. Jour., vol. liii, p. 42 (correspondence).

Reviews the paper by N. A. Pratt on the same subject.

228 —— The present formation of phosphatic concretions in deep-sea deposits.

Eng. and Min. Jour., vol. liii, pp. 499–500.

Gives the results of the *Challenger* expedition in this connection and quotes from the published report.

229 —— Notes on the geological occurrence of phosphate of lime in the United States and Canada.

Am. Inst. Min. Engrs., Trans., vol. xxi, pp. 139–157.

Describes the occurrence of apatite in gneiss in Canada and the phosphate deposits of South Carolina and Florida, and discusses their geologic occurrence and origin.

230 **Davis** (William Morris). The Catskill delta in the Post-Glacial Hudson estuary.

Boston Soc. Nat. Hist., Proc., vol. xxv, pp. 318–335.

Abstract: Jour. of Geol., vol. i, pp. 97–98.

Gives a sketch of the history of the Hudson River valley and describes the glacial deposits of the region.

231 —— Supplementary note: On the drainage of the Pennsylvania Appalachians.

Boston Soc. Nat. Hist., Proc., vol. xxv, pp. 418–420.

Refers to a previous postulate of the author employed in his discussion of the rivers and valleys of Pennsylvania.

232 —— The subglacial origin of certain eskers.

Boston Soc. Nat. Hist., Proc., vol. xxv, pp. 477–499.

Abstract: Jour. of Geol., vol. i, pp. 95–96.

Discusses the relation of climate to the results of erosion processes and the origin and deposition of certain eskers in Massachusetts. Concludes that they were formed during the closing stage of the last glacial epoch, and that their present form and structure indicate their sub-glacial origin.

233 —— The Loup rivers in Nebraska.

Science, vol. xix, pp. 107–108 and 220–221 (correspondence).

Comments on an article on the same subject by L. E. Hicks.

234 —— The Osage River and the Ozark uplift.

Science, vol. xxii, pp. 276–279 (correspondence).

Reviews a previous article on the subject by Arthur Winslow and discusses the evidence bearing on the question.

235 —— The lost volcanoes of Connecticut.

Pop. Sci. Mo., vol. xl, pp. 221–235.

Describes the occurrence of lava ash beds in Connecticut, and discusses the evidences indicating the location of the volcano from which they were derived.

236 **Dawson** (George M.). Notes on the geology of Middleton Island, Alaska.

Geol. Soc. Am., Bull., vol. iv, pp. 427–431.

Describes some specimens of bowlder clay and other material collected on this island, including a few fossil shells, and concludes that the material is of Pleistocene age and referable to the Glacial period.

237 —— Note on the distribution of the upturned Cretaceous beds of British America.

Am. Jour. Sci., 3d ser., vol. xliii, pp. 433–435 (correspondence).

Describes the divisions of the Cordilleran belt in British America, with a brief reference to the distribution and structure of the Cretaceous strata.

238 **Dawson** (J. William). On the correlation of early Cretaceous floras in Canada and the United States, and on some new plants of this period.

Can. Roy. Soc., Trans., vol. x, sect. iv, pp. 79–93.

Abstract: Am. Jour. Sci., 3d ser., vol. xlv, p. 439 (½ p.).

Gives a summary of geologic knowledge concerning rocks of Cretaceous age. Describes some species of the Kootenai formation and states that they represent Lower Cretaceous facies, an indication that the Kootenai belongs to the lowest portion of the Cretaceous.

239 **Dawson** (J. William). On new species of Cretaceous plants from Vancouver Island.

Can. Roy. Soc., Proc. and Trans., vol. xi, sect. iv, pp. 53–73, pls. v–xiv.

Contains a statement concerning the locality where the collections were made and a description of the plant remains found.

240 —— Geological notes.

Can. Rec. Sci., vol. v, pp. 386–393.

Reviews the recent literature bearing on the classification of the oldest rocks and some recent papers on glacial phenomena. Mentions the discovery of fish remains in the Siluro-Cambrian of Colorado.

241 —— Note on fossil sponges from the Quebec group (Lower Cambro-Silurian) at Little Metis, Canada.

Abstract: Geol. Soc. Am., Bull., vol. iv, pp. 409–410.

242 —— and **Penhallow** (D. P.). Parka decipiens.

Can. Roy. Soc., Trans., vol. ix, sect. iv, pp. 3–16.

Abstract: Am. Geol., vol. ix, p. 341.

Gives a historical and geologic sketch of the fossil and the microscopical and botanical results of a study of the specimens.

243 **Daubrée** (M.). Recherches expérimentales sur le rôle possible des gaz à hautes températures, doués de très fortes pressions et animés d'un mouvement fort rapide, dans divers phénomènes géologiques.

Soc. Géol. de France, Bull., 3d ser., vol. xix, pp. 313–354.

In referring to the relative altitude of volcanoes and their distribution, reference is made to those occurring in western North America.

243*a* **Dean** (George W.). Catalogue of the shell-bearing mollusca of Portage County, Ohio.

Am. Nat., vol. xxvi, pp. 11–23.

244 **Deby** (J.). The fossil Aulisci of California.

Torr. Bot. Club, Bull., vol. xx, pp, 118–119.

Gives a list of 30 forms from California.

244*a* **Derby** (Orville A.). On the separation and study of the heavy accessories of rocks.

Roch. Acad. Sci., Proc., vol. i, pp. 198–206.

Abstract: Am. Nat., vol. xxvi, pp. 694–695.

Describes the apparatus used by the author to separate the mineral constituents of rocks, the method of operation and its application to the study of rock-forming minerals.

244*b* —— A study in consanguinity of eruptive rocks.

Jour. of Geol., vol. i, pp. 597–605.

Describes the occurrence and character of some eruptive rocks of Brazil.

245 **Dewar** (R.). The occurrence of gold and silver in galena and iron pyrites.

Can. Inst., Trans., vol. ii, part i, pp. 121–127.

Contains notes on the association of these minerals and on the process of their deposition.

245*a* **Diest** (P. H. van). On the artesian wells of Denver.

Colo. Sci. Soc., Proc., vol. iv, pp. 1–6.

Gives a brief summary of the history of the Denver artesian basin, and discusses the evidences which indicate the character and extent of the collecting area, the oscillations of the water level, and the average available supply of artesian water in this basin. Considers that at about 1,500 feet in depth a supply of water can be obtained from the basal sandstones of the Laramie.

245*b* —— Evidence bearing on the formation of ore deposits by lateral secretion.

Colo. Sci. Soc., Proc., vol. iv, pp. 340–347.

Describes the geology and discusses the origin of the veins and ore deposits of the John Jay Mine, Boulder County, Colorado.

246 **Diller** (Joseph Silas). On a late volcanic eruption in northern California and its peculiar lava.

U. S. Geol. Surv., Bull. No. 79.

Abstract: Am. Geol., vol. ix, pp. 265–266 (⅔ p.).

Noticed in Record for 1891.

247 —— Mica-peridotite from Kentucky.

Am. Jour. Sci., 3d ser., vol. xliv, pp. 286–289.

Abstract: Am. Nat., vol. xxvii, p. 273 (⅓ p.).

Describes the dike in which the specimen occurs and the mineralogic characteristics of the rock.

248 —— The Tertiary revolution in the topography of the Pacific Coast.

Abstract: Am. Jour. Sci., 3d ser., vol. xlvi, p. 74 (⅓ p.).

Paper read before the Geological Society of Washington.

249 —— Note upon some observations on the auriferous gravels of lacustral origin in the region of Taylorsville, Cal.

Am. Jour. Sci., 3d ser., vol. xlvi, pp. 398–399 (correspondence).

Describes the general distribution of the gravels of the region and refers to the existence of a fault, indicating the displacement of the auriferous gravel since its deposition.

250 —— Lassen Peak sheet.

U. S. Geol. Surv., Geol. map of the U. S., preliminary edition, 1892.

Describes the topography of the area, the character of the metarphic rocks, the unaltered sedimentaries and igneous rocks. Gives general sketch of the geologic history of the region and its economic resources. Accompanied by topographic, areal, and economic geologic maps and a sheet illustrating the Cinder Cone.

251 —— Geology of the Taylorsville region of California.

Geol. Soc. Am., Bull., vol. iii, pp. 369–394.

Abstracts: Am. Jour. Sci., 3d ser., vol. xliv, p. 330 (½ p.); Am. Geol., vol. x, p. 183 (⅓ p.).

Reviews the previous work in this region and gives a table summarizing the geologic systems represented and their thicknesses. Describes the eruptive action which continued at intervals from the Paleozoic to Pleistocene time, the anticlinal and synclinal structure developed, and the character and displacement of the Taylorsville fault

252 **Diller** (Joseph Silas). Cretaceous and early Tertiary of northern California and Oregon.

Geol. Soc. Am., Bull., vol. iv, pp. 205–224.

Abstract: Am. Geol., vol. xii, pp. 119–120 (½ p.).

Discusses the relation, distribution, and composition of the Shasta-Chico series and gives list of fossils found in the different subdivisions of the series. Reviews the evidences of the pre-Cretaceous elevation of the Klamath Mountains and the Sierra Nevada, and the inter-Cretaceous-Tertiary upheaval of the former.

252*a* **D'Invilliers** (E. V.), **McCreath** (A. S.) and. The Clinch Valley coal fields.

See McCreath (A. S.) and D'Invilliers (E. V.), 611.

253 **Dodge** (William W.) and **Beecher** (Charles E.). On the occurrence of Upper Silurian strata near Penobscot Bay, Maine.

Am. Jour. Sci., 3d ser., vol. xliii, pp. 412–418, with map.

Describes the formations in this region and gives a list of Clinton and Niagara fossils, with their location.

254 **Donald** (J. F.). The occurrence of platinum in Canada.

Eng. and Min. Jour., vol. lv, pp. 81–82.

Remarks on the occurrence of platinum in eastern Canada and in British Columbia.

255 **Douglas** (James). The copper resources of the United States.

Sci. Amer. Suppl., vol. xxxv, pp. 14183–14186.

Describes the copper mines of the Lake Superior, Arizona, Montana, and other districts in the United States.

256 **Drake** (N. F.). Stratigraphy of the Triassic formation of northwest Texas.

Texas Geol. Surv., 3d Ann. Rept., pp. 228-247.

Includes a description of the lithologic and stratigraphic relations of the beds comprising the formation in this region.

257 ——- Report on the Colorado coal field of Texas.

Texas Geol. Surv., 4th Ann. Rept., pp. 357–446.

Describes the structural and lithologic characters of the subdivisions of the Cretaceous and Carboniferous formations of the district, the character and extent of the coal seams and the occurrence of iron ore, clay, and building stones. Illustrated by sections and two maps showing the areal geology and extent of the coal field.

258 **Drummond** (A. T.). The physical features of the environs of Kingston, Ontario, and their history.

Can. Rec. Sci., vol. v, pp. 108–117.

Describes the relations of the Laurentian and Cambrian rocks and the Quaternary beds of this locality.

259 **Dryer** (Charles R.) Report upon the geology of Dekalb County, Indiana.

Ind. Dept. Geol. and Nat. Hist., 16th Rept. 1888, pp. 98–104.

Describes the topographic features and drift deposits of this county.

260 **Dryer** (Charles R.). Report upon the geology of Allen County, Indiana.

Ind. Dept. Geol. and Nat. Hist., 16th Rept., 1888, pp. 105–130.

Divides the county into six districts and describes the glacial features of each. Gives a section exhibited by an artesian well boring, showing the presence of Silurian limestones and shales underneath the drift-covering.

261 —— Report upon the geology of Steuben County, Indiana.

Ind. Dept. Geol. and Nat. Hist., 17th Rept., 1891, pp. 114–134.

Describes the glacial moraines and drainage system of the county.

262 —— Report upon the geology of Whitley County, Indiana.

Ind. Dept. Geol. and Nat. Hist., 17th Rept., 1891, pp. 160–170.

Describes the glacial moraine covering this region and the drainage systems.

263 **Dumble** (Edwin T.). Note on the occurrence of grahamite in Texas.

Am. Inst. Min. Engrs., Trans., vol. xxi, pp. 601–605.

Abstract: Am. Geol., vol. xi, p. 120 (8 l.).

Describes the geology of the region in which the specimens were found and gives the section of the two bluffs, made up of Tertiary strata, in which they occur and chemical analyses.

264 —— Sources of the Texas drift.

Texas Acad. Sci., Trans., vol. i, pp. 11–13.

Abstract: Am. Nat., vol. xxvii, pp. 269–270 (⅛ p.).

Describes the lithologic character of the drift of the Rio Grande and Colorado River basins and of eastern Texas, and gives the author's conclusions as to the source of the material.

265 —— Volcanic dust in Texas.

Texas Acad. Sci., Trans., vol. i, pp. 33–34.

Describes briefly the geology of the region and the section in which the volcanic dust occurs.

266 —— Notes on the geology of the valley of the middle Rio Grande.

Geol. Soc. Am., Bull., vol. iii, pp. 219–230.

Abstract: Am. Geol., vol. x, pp. 65–66 (⅛ p.).

Describes the general topographic and geologic features of the region. The formations represented comprise the Neocene, Eocene, and Cretaceous.

267 —— Second report of progress.

Texas Geol. Surv., 2d Rept. of Prog., 1891, pp. 7–91.

Gives an account of the work done on the general and economic geology of the Carboniferous, Cretaceous, and Tertiary sections of the State and includes reports of the several assistant geologists.

268 —— [Report of State Geologist.]

Texas Geol. Surv., 3d Ann. Rept., 1891, pp. xvii–lxi.

Gives a summary of the geologic work done during the year and the reports of the assistant geologists.

269 —— Progress of geological surveys in Texas.

Eng. and Min. Jour., vol. lv, p. 55.

Remarks on the work and results obtained by the Geological Survey of Texas in 1892.

270 **Dumble** (Edwin T.). Report of the State Geologist for 1892.

Texas Geol. Surv., 4th Ann. Rept., pp. xvii–xxxv.

Includes an account of the work done in 1892, with remarks on the deposits of the Coastal slope and the Colorado coal field, and on the deposits of the precious metals associated with copper and lead in the Trans-Pecos district.

271 —— Report on the brown coal and lignite of Texas.

Texas Geol. Surv., 1892, pp. 17–243.

Abstracts: Am. Geol., vol. xi, p. 209; Am. Nat., vol. xxvii, p. 379 (½ p.).

Describes the origin, formation, and characters of brown coal, the geology of the Texas deposits, and the occurrence and composition of the Tertiary brown coals in the different States, and compares them with European and bituminous coals.

272 —— and **Cummins** (W. F.). The Double Mountain section.

Am. Geol., vol. ix, pp. 347–351.

Describes the general features of the region and the character of the Cretaceous, Triassic, and Permian beds which make up the mountain mass and mentions the fossils found in them.

273 —— The Kent section and Gryphæa tucumcarii Marcou.

Am. Geol., vol. xii, pp. 309–314.

Gives the section occurring at this locality in western Texas and a list of fossils found, representing three divisions of the Cretaceous.

274 —— and **Harris** (G. D.). The Galveston deep well.

Am. Jour. Sci., 3d ser., vol. xlv, pp. 38–42.

Gives the section shown by this well to a depth of 3,070 feet and a summary of conclusions drawn from a study of the fossils obtained from the well.

275 **Dunn** (R. L.). Siskiyou County [California].

Cal. State Min. Bur., 11th Rept., pp. 420–449.

Describes the geologic structure of the Coast Range, with notes on some of the mines of the county.

276 —— Trinity County [California].

Cal. State Min. Bur., 11th Rept., pp. 480–484.

Brief general description of the placer deposits.

277 **Dutton** (C. E.). On the greater problems of physical geography.

Abstract: Am. Jour. Sci., 3d ser., vol. xliv, p. 258 (⅔ p.).

277*a* **Dwight** (A. S.). Notes on Montana sapphires.

Colo. Sci. Soc., Proc., vol. iv, pp. 174–175.

Describes the occurrence of sapphires in the bars of placer gravel and considers that they originally came from a dike.

278 **Dyche** (D. T. D.). The crinoid Heterocrinus subcrassus.

Science, vol. xx, p. 66.

Describes its structural characteristics.

E.

279 **Eakins** (L. G.). A new meteorite from Hamblen County, Tenn.

Am. Jour. Sci., 3d ser., vol. xlvi, pp. 283–285.

Gives the chemical composition of the metallic and siliceous portions of the meteoric mass.

279*a* **Eakins** (L. G.), **Cross** (W.) and. A new occurrence of ptilolite.
See Cross (W.) and Eakins (L. G.), 198.

280 **Eakle** (Arthur S.). On some dikes occurring near Lyon Mountain, Clinton County, N. Y.
Am. Geol., vol. xii, pp. 31–36.
Describes the location of the dikes, shown on an accompanying map of the region, and the petrographic characters and chemical composition of the dike rocks.

281 **Earle** (Charles). Revision of the species of Coryphodon.
Am. Mus. Nat. Hist., Bull., vol. iv, pp. 149–166.
Abstract: Am. Jour. Sci., 3d ser., vol. xlv, p. 160 (⅓ p.).
Compares the Coryphodon material recently procured from the Wasatch formation in Wyoming with that contained in other collections.

282 —— A memoir upon the genus Palæosyops Leidy and its allies.
Phila. Acad. Nat. Sci. Jour., 2d ser., vol. ix, pp. 267–388, pls. x–xvii.
Describes the geologic succession, distribution, and characters of the different species.

283 —— **Wortman** (J. L.) and. Ancestors of the tapir from the lower Miocene of Dakota.
Am. Mus. Nat. Hist., Bull., vol. v, pp. 159–180.
Discusses the origin of the tapir in America, describes species from the Miocene of South Dakota, and reviews the evidences of relationship between American and European species of Protapirus.

284 **Edwards** (Arthur M.). Hudson River "Fiord."
Am. Jour. Sci., 3d ser., vol. xliii, pp. 182–183.
Gives a list of fossils found in the soundings from the Hudson River "Fiord," and concludes that, as the microscopic organisms are not those of Newark Bay, the "fiord" is not a continuation of that bay, but of the Hudson River.

285 —— On a Champlain (?) deposit of Diatomaceæ belonging to the littoral plain.
Am. Jour. Sci., 3d ser., vol. xlv, pp. 385–388.
Gives a list of species collected in New Jersey and describes the glacial geology of the region.

286 —— The Diatomaceæ of the Triassic (?) sandstone of New Jersey.
Am. Nat., vol. xxvii, pp. 817–818.
Remarks on finding Diatomaceæ in Tertiary clays of New Jersey.

287 **Eldridge** (George H.). The Florence oil field, Colorado.
Am. Inst. Min. Engrs., Trans., vol. xx, pp. 442–462.
Gives a history of the development of the petroleum industry in this region, and describes the topographic and geologic features and structure. Describes the oil-bearing horizon, its thickness and extent, and the source of the oil. Discusses the relation between wells, their yield, and describes the character and treatment of the products. Discussed by F. H. Newell, p. 462.

288 **Eldridge** (George H.). A preliminary sketch of the phosphates of Florida.

Am. Inst., Min. Engrs., Trans., vol. xxi, pp. 196–231.

Describes the topographic and geologic features of the State, the character and occurrence of the four classes of Florida phosphates, and discusses their origin. Gives chemical analyses of a number of phosphate specimens. Presents a map showing the location and extent of the phosphate districts.

289 **Ells** (R. W.). The Laurentian of the Ottawa district.

Geol. Soc. Am., Bull., vol. iv, pp. 349–360.

Abstract: Am. Nat., vol. xxvii, p. 996 (½ p.).

Reviews the literature on the geology of this region and the work of Sir W. Logan on the Laurentian. Gives data obtained in an examination of the Trembling Mountain section and the region between the anorthosite area and Gatineau River. Describes the Laurentian gneiss and limestone and associated intrusive rocks, and presents a résumé of the facts and the author's conclusions.

290 —— The geology of the proposed tunnel under the Northumberland strait.

Can. Roy. Soc., Proc. and Trans., vol. xi, sect. iv, pp. 75–84, with map.

Describes the geology of the region and gives the records of ten bore holes made along the line of the proposed tunnel.

291 **Elrod** (Moses N.) and **Benedict** (A. C.). Geology of Wabash County.

Ind. Dept. Geol. and Nat. Hist., 17th Rept., 1891, pp. 192–272.

Describes the topographic features and gives a list of fossils found in this county. Gives the section shown at various localities and the lithologic character of the Niagara limestones, and discusses the probability of a tilting of these beds. Describes the Quaternary deposits and gives sections displayed by several gas wells.

292 **Emerson** (B. K.). Proofs that the Holyoke and Deerfield trap sheets are contemporaneous flows and not later intrusions.

Am. Jour. Sci., 3d ser., vol. xliii, pp. 146–148.

Gives an abstract of the data showing that the main trap sheets of Massachusetts are contemporaneous and easily distinguished from smaller intrusive masses.

293 —— Notes upon two bowlders of a very basic eruptive rock from the west shore of Canandaigua Lake and their contact phenomena upon the Trenton limestone.

N. Y. State Mus., 46th Ann. Rept., pp. 251–255.

Describes the petrographic characters of the specimens and the contact phenomena.

294 —— Hawley sheet.

U. S. Geol. Surv., Geol. atlas of the U. S., preliminary edition, 1892.

Describes the topographic features of the region, the lithologic character, structure and relations of the Cambrian and Silurian formations. Illustrated by topographic, colored areal and economic geologic and structure section maps.

295 **Emerson** (B. K.). Outlines of the geology of the Green Mountain region in Massachusetts.

U. S. Geol. Surv., Geol. atlas of the U. S., Hawley sheet, preliminary edition, 1892.

Describes the topographic features of the region and the lithologic character, structure and relations of the Algonkian, Cambrian, Silurian, and Devonian formations.

296 **Emmens** (Stephen H.). The nickel deposits of North Carolina.

Eng. and Min. Jour., vol. liii, pp. 476–477.

Quotes from the previous descriptions of these deposits, compares them with the New Caledonia deposits, and describes the character and extent of the ore bodies.

297 —— Faulting in veins.

Eng. and Min. Jour., vol. liii, p. 492, and vol. liv, p. 27 (correspondence).

Reviews statements of John A. Church on this subject.

298 **Emmons** (Samuel Franklin). Progress of the precious-metal industry in the United States since 1880.

U. S. Geol. Surv., Min. Res., 1892, pp. 46–94.

Gives a general review of the progress of the industry and a brief description of the principal ore deposits in the various States and Territories, tables of production, and a forecast of future production.

299 —— Fluorspar deposits of southern Illinios.

Am. Inst. Min. Engrs., Trans., vol. xxi, pp. 31–53.

Gives a historical sketch of mining operations in this region. Describes the lithologic character of the strata and discusses the evidences which indicate the geologic subdivisions to which they should be assigned. Gives an account of the distribution of lead and associated minerals in limestones of the Mississippi Valley. Describes the mining developments of the district and discusses the manner of formation of the deposits and the origin of the vein material.

300 —— Faulting in veins.

Eng. and Min. Jour., vol. liii, pp. 548–549.

Refers to previous communications on this subject and discusses the occurrence and characters of fracture planes and the conditions of their development and the general features of fault phenomena.

301 **Eyerman** (John). Bibliography of North American vertebrate paleontology for the year 1891.

Am. Geol., vol. ix, pp. 249–256.

Presents a bibliography and a list of new forms described in the papers mentioned.

302 —— Bibliography of North American vertebrate paleontology for the year 1892.

Am. Geol., vol. xi, pp. 388–393.

Contains a list of papers bearing on North American vertebrate paleontology for the year 1892.

F.

302*a* **Faber** (Charles), **Miller** (S. A.) and. Description of some sub-Carboniferous and Carboniferous Cephalopoda.

See Miller (S. A.) and Faber (C.), 671.

303 **Faber** (Charles), **Miller** (S. A.) and. Some new species and new structural parts of fossils.

Cinn. Soc. Nat. Hist. Jour., vol. xv, pp. 79–87.

304 **Fairbanks** (Harold W.). Geology and mineralogy of Shasta County [California].

Cal. State Min. Bur., 11th Rept., pp. 24–53.

Describes the lithologic character and distribution of the Cretaceous and metamorphic rocks in this county, with notes on the occurrence of coal seams and of the precious metals. Accompanied by colored geologic map.

305 —— Notes on the geology and mineralogy of portions of Tehama, Colusa, Lake, and Napa counties [California].

Cal. State Min. Bur., 11th Rept., pp. 54–75.

Describes the Cretaceous and crystalline rocks of these counties, with notes on some of their mineral deposits.

306 —— Geology of San Diego County; also of portions of Orange and San Bernardino counties [California].

Cal. State Min. Bur., 11th Rept., pp. 76–120.

Contains description of the crystalline, Cretaceous, Tertiary, and Quaternary rocks in these counties, with notes on some mineral deposits, and accompanied by a colored geologic map.

307 —— The relation between ore deposits and their inclosing walls.

Eng. and Min. Jour., vol. lv, p. 200.

Describes the Mother Lode of California, and discusses the question whether certain wall rocks indicate rich mines and whether the metals are derived from such walls or from deep-seated regions. Concludes that mineral deposits usually occur in regions of great disturbance, producing chemical action and access upward of mineral bearing solutions through existing fissure systems.

308 —— The validity of the so-called Wallala beds as a division of the California Cretaceous.

Am. Jour. Sci., 3d ser., vol. xlv, pp. 473–478.

Reviews the evidences upon which the Wallala beds are separated from the Chico and Shasta series. Gives the results of observations in Lower California, and in southern California and concludes that the evidence does not warrant the separation of the Shasta beds from the Chico.

309 —— The pre-Cretaceous age of the metamorphic rocks of the California Coast ranges.

Am. Geol., vol. ix, pp. 153–166.

Quotes the opinions of other writers on the age of these rocks. Describes the structural conditions and fossil contents of the strata in this region, and concludes that the Coast ranges and Sierras were upheaved and metamorphosed prior to the Cretaceous, and, therefore, the gold-bearing slates are pre-Cretaceous.

310 **Fairbanks** (Harold W.). Notes on a further study of the pre-Cretaceous rocks of the California Coast ranges.

Am. Geol., vol. xi, pp. 69–84, with map.

Describes the general character and structure of the formations represented in the Coast ranges from the author's recent observations. Refers to the finding of Inoceramus in the San Francisco sandstones and Aucella in the metamorphic rocks and its bearing on the Cretaceous age of the beds. Concludes that the axes of the Coast ranges and Sierras are structurally closely related and were first raised during the Post-Jurassic upheaval.

311 —— Notes on the occurrence of rubellite and lepidolite in southern California.

Science, vol. xxi, pp. 35–36.

Abstract: Am. Nat., vol. xxvii, p. 1091, 5 l.

Gives a brief account of the geology of the locality in which this mineral association occurs and a description of their mineralogic characters.

312 **Fairchild** (H. L.). A section of the strata at Rochester. N. Y., as shown by a deep boring.

Roch. Acad. Sci., Proc., vol. i, pp. 182–186.

Abstract: Am. Nat., vol. xxvi, pp. 695–696.

Gives a table showing the correspondence of the exposed strata and the first part of the well record, followed by a condensed section of the well boring. Compares the published and measured records of rocks in this vicinity with those of the well record.

313 **Farish** (John B.). The ore deposits of Newman Hill [Rico, Colo.].

Colo. Sci. Soc., Proc., vol. iv, pp. 151–164.

Min. and Sci. Review, vol. xxviii, No. 26, p. 4, vol. xxix, No. 1, pp. 4–5 and No. 2, pp. 4–5.

Describes the geologic features of the locality and the structural and mineralogic characteristics of the ore bodies.

314 **Farnsworth** (P. J.). The Great Lake basins.

Science, vol. xx, p. 74.

Discusses the evidences as to the origin of these lake basins.

315 **Fechet** (Eugene O.). The mines of Sierra Mojada, Mexico.

Eng. and Min. Jour., vol. lv, pp. 151–152.

Describes the general topographic and geologic features of the region. The ore bodies occur in a Cretaceous limestone and their mineral contents are principally silver, lead, and copper.

316 **Felix** (J.) and **Lenke** (H.). Beitrage zur geologie und paleontologie der Republik Mexico.

Part i, Leipzig, 1890; part iii, Stuttgart, 1891.

Abstract: Am. Geol., vol. x, pp. 120–121.

317 —— Ueber die tektonischen Verhältnisse der Republik Mexico.

Zeit. Deut. geol. Gesell., Band xliv, Heft 2, 1892, pp. 303–323.

Describes the topographic and geologic structure of the mountain ranges and plateau of Mexico. Considers that the volcanoes owe their origin to and are arranged along certain definite fissure systems.

318 **Fenner** (Clarence). The Old Telegraph Mine, Bingham Canyon, Utah.

School of Min. Quart., vol. xiv, pp. 354–358.

Describes the character and structure of the ore bodies in this mine.

319 **Ferrier** (W. F.). Notes on the microscopical character of some of the rocks of the counties of Quebec and Montmorency.

Can. Geol. Surv., Reports, vol. v, new ser., part i, 1890–91, Report L, appendix, pp. 73–82.

Quotes Dr. Adams's scheme for the classification of the rocks of the gabbro family and describes the megascopic and microscopic characters of hornblende-granite-gneiss, mica-diorite-gneiss, anorthosite, norite, gabbro-gneiss, and pyroxenite-granite-gneiss.

320 **Fisher** (Osmond). Rigidity not to be relied upon in estimating the earth's age.

Am. Jour. Sci., 3d ser., vol. xlv, pp. 464–468.

Reviews the paper by Clarence King, "The age of the earth," and quotes from other writers concerning the tidal rigidity of the earth. Concludes that rigidity can not be relied upon as furnishing data from which to estimate the earth's age.

321 **Fletcher** (Hugh). Report on the geological surveys and explorations in the counties of Pictou and Colchester, Nova Scotia.

Can. Geol. Surv., Reports, vol. v, new ser., part ii, 1890–91, Report P, p. 193.

The formations of the region range from the post-Tertiary to the Cambro-Silurian and are cut by dikes and sheets of igneous rocks. Describes sections shown at various points, the deposits of coal and iron, and the traces of lead and copper that were found.

322 **Foerste** (Aug. F.). Studies on the Chipola Miocene of Bainbridge, Ga., and of Alum Bluff, Fla., with an attempt at correlation of certain Grand Gulf group beds with marine Miocene beds eastward.

Am. Jour. Sci., 3d ser., vol. xlvi, pp. 244–254.

Describes the general character and relations of the strata in this region, with special reference to exposures at Bainbridge and Alum Bluff. Presents a provisional list of Gasteropoda Gully species, showing their geologic and geographic distribution, with notes on the various species.

323 —— New fossil localities in the early Paleozoics of Pennsylvania, New Jersey, and Vermont, with remarks on the close similarity of the lithologic features of these Paleozoics.

Am. Jour. Sci., 3d ser., vol. xlvi, pp. 435–444.

Describes the general relations and lithologic character of the Cambrian and Silurian strata in the portions of the States mentioned and their fauna, as shown by the observations of various investigators. Discusses the correlation of the beds in the several districts, and presents a geologic sketch map of the portions of New Jersey and Vermont.

324 **Foerste** (Aug. F.). An examination of Glyptodendron Claypole, and of other so-called Silurian land plants from Ohio.

Am. Geol., vol. xii, pp. 133–141.

Discusses the characteristics of the specimens found in rocks of Clinton age in Ohio, said to be land plants. Considers that at present there is no evidence of the existence of land plants in the region of the Cincinnati anticlinal during Clinton time.

325 —— Remarks on specific characters in Orthoceras.

Am. Geol., vol. xii, pp. 232–236.

Describes some of the special characteristics of Orthoceras.

326 —— The reproduction of arms in orinoids.

Am. Geol., vol. xii, pp. 270–271, (¼ p.) (correspondence).

327 **Fontaine** (William M.). Description of some fossil plants from the Great Falls coal field of Montana.

U. S. Nat. Mus., Proc., vol. xv, pp. 487–495, pls. lxxxii–lxxxiv.

Describes the general character of the flora represented and the characteristics of several new species.

328 —— Notes on some fossil plants from the Trinity division of the Comanche series of Texas.

U. S. Nat. Mus., Proc., vol. xvi, pp. 261–282, pls. xxxvi–xliii.

Abstract: Am. Geol., vol. xii, pp. 327–328.

329 **Foote** (A. E.). A new locality for meteoric iron, with a preliminary notice of the discovery of diamonds in the iron.

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xl, pp. 279–283.

Describes the locality in Arizona and the specimens obtained, and remarks on the occurrence of small black diamonds in them.

330 —— Preliminary notice of a meteoric stone seen to fall at Bath, South Dakota.

Am. Jour. Sci., 3d ser., vol. xlv, p. 64.

Gives a brief description of the stone, illustrated by photograph, pl. iii.

331 **Forrester** (Robert). Coal fields of Utah.

U. S. Geol. Surv., Min. Res., 1892, pp, 511–520.

The Coal Measures of the Laramie group are best developed on the eastern slopes of the Wasatch and the beds attain a maximum thickness of 28 feet. Coal also occurs in the Montana and Colorado Cretaceous. Gives analyses of coal from different localities.

332 **Forstall** (A. E.). The origin of coal and petroleum.

Sci. Amer. Suppl., vol. xxxiv, pp. 13796–13797.

Gives an account of the conditions existing during the formation of coal and petroleum and reviews the literature on the question of their origin.

333 **Freeland** (Francis T.). Fault rules.

Am. Inst. Min. Engrs., Trans., vol. xxi, pp. 491–502.

Discusses the general characteristics of fault phenomena and gives a number of rules to be followed in mining where faults occur and a bibliography of the subject.

334 **Fuller** (Homer T.). Effects of droughts and winds on alluvial deposits in New England.

Geol. Soc. Am., Bull., vol. iii., pp. 148–149.

Describes terraces once covered with vegetation, but which are now almost entirely denuded, and states that the wind striking them at an angle carries the sand to the nearest lower spot to the leeward.

G.

335 **Gannett** (Henry). The mapping of the United States.

Scottish Mag., vol. viii, pp. 150–153.

Gives a history of the various surveying expeditions that have been made in the United States and a brief account of the character of the topographic maps now being executed by the U. S. Geological Survey.

336 **Garside** (G. W.). The mineral resources of southeast Alaska.

Min. and Sci. Review, vol. xxx, No. 7, pp. 4–5, and No. 8, pp. 4–5; Am. Inst. Min. Engrs., Trans., vol. xxi, pp. 815–823.

Abstract: Eng. and Min. Jour., vol. lv, pp. 175–176.

Describes the character and value of the precious metal ores found in the several districts of this region, accompanied by sketch map of a part of Alaska, showing mineral belt.

337 **Gaudry** (M. Albert). Excursion dans les Montagnes rocheuses.

Soc. Géol. de France, Bull., 3d ser., vol. xix, No. 12, pp. 936–942.

Gives a general geologic description of the route traversed by an excursion composed of members of the Fifth International Congress of Geologists, crossing many of the Eastern, Middle, and Western States of the United States, and includes a description of the mammalian and other fossil faunas found in some of the Western States.

338 —— Similitudes dans la marche de l'évolution sur l'ancien et le nouveau continent.

Soc. Géol de France, Bull., 3d ser., vol. xix, No. 12, pp. 1024–1035.

Compares the characteristics of certain American faunas with those of Europe, and discusses the changes that have taken place in each and their relation to the progress of evolution.

339 **Geer** (Gerard de). On Pleistocene changes of level in eastern North America.

Am. Geol., vol. xi, pp. 22–44; Boston Soc. Nat. Hist., Proc., vol. xxv, pp. 454–477.

Gives a general statement of the methods and results of the author's investigations in Europe and North America. Considers that continental changes of level are closely connected with the local structure of the earth's crust and that no changes in the level of the sea can account for the phenomena.

340 —— Isobases of the post-Glacial elevation.

Am. Geol., vol. ix, pp. 247–249.

Gives an account of the author's observations of the glacial deposits in various parts of the United States and Canada.

341 —— Quaternary changes of level in Scandinavia.

Geol. Soc. Am., Bull., vol. iii, pp. 65–68, with map.

Describes the author's methods of determining the marine boundary and gives the results of his observations.

342 **Geikie** (James). Glacial geology.

Smith. Inst., Ann. Rept., 1890, pp. 221–230.

Discusses the general conclusions of investigators of glacial phenomena and deposits in different portions of the world.

343 —— Address as president of the Section of Geography.

Brit. Assoc. Adv. Sci., Report 1892, pp. 794–810; Scottish Geog. Mag., vol. viii, pp. 457–479.

Describes the geographic development of coast lines and the orographic movements that have influenced their location and direction in North America and other parts of the earth.

344 **Genth** (Frederick A.). Contributions to mineralogy.

Am. Jour. Sci., 3d ser., vol. xliii, pp. 184–189.

Notes on hübnerite, hessite, bismutite, and natrolite.

345 —— On penfieldite, a new species.

Am. Jour. Sci., 3d ser., vol. xliv, pp. 260–261 (correspondence).

346 —— Contributions to mineralogy, No. 54, with crystallographic notes by S. L. Penfield.

Am. Jour. Sci., 3d ser., vol. xliv, pp. 381–389.

Notes on aguilarite, metacinnabarite, löllingite, rutile, quartz from the alteration of orthoclase, danalite, yttrium-calcium fluoride, cyrtolite, lepidolite, and fuchsite.

347 —— On the "anglesite" associated with boléite, No. 55.

Am. Jour. Sci., 3d ser., vol. xlv, pp. 32–33.

Abstract: Am. Nat., vol. xxvi, p. 1090.

Gives the crystallographic characters of the crystals examined and two chemical analyses.

348 —— The minerals of North Carolina.

U. S. Geol. Surv., Bull. No. 74.

Abstract: Am. Geol., vol. ix, p. 342 ($\frac{1}{3}$ p.).

349 **Gibson** (A. M.). Report on the Coal Measures of Blount Mountain, with map and sections.

Ala. Geol. Surv., 1893, pp. 7–80.

Describes the topography and geologic structure of the region and the stratigraphy of the lower and upper Coal Measures, with a detailed description of the coal seams. Discusses the correlation of the various seams and gives chemical analyses of some of the coals.

350 **Gilbert** (Grove Karl). Discussion of the papers "Relationship of the glacial lakes, Warren, Algonquin, Iroquois, and Hudson-Champlain," and the two papers by J. W. Spencer, "The Iroquois shore north of the Adirondacks" and "Channels over divides not evidence per se of glacial lakes."

Geol. Soc. Am., Bull., vol. iii, pp, 492–494.

Reviews the descriptions given in the above-named papers and concludes that the Iroquois lake was bounded on the northeast by a wall of ice and that its surface level was determined by the altitude of a divide near Rome. Concerning the terraces mentioned in the last paper, considers there are certain features which indicate they are not littoral.

351 **Gilbert** (Grove Karl). Continental problems.

Geol. Soc. Am., Bull., vol. iv, pp. 179–190.

Abstracts: Am. Geol., vol. xii, pp. 118–119; Jour. of Geol., vol. i, pp. 204–205.

Differentiates the continental from the oceanic plateaus. Discusses the question of rigidity versus isostasy, the origin of the continental plateaus, the cause of continental movements of elevation and subsidence, and the permanence and growth of continents.

352 —— Post-Glacial anticlinal ridges near Ripley, N. Y., and near Caledonia, N. Y.

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xl, pp. 249–250.

An examination of these ridges confirms the opinion previously expressed concerning certain other anticlinal ridges, that the phenomena are superficial. They are due to the sinking of the overlying Corniferous limestone by the removal of salt and gypsum by underground water.

353 **Goldsmith** (E.). Notes on some minerals and rocks.

Phila. Acad. Nat. Sci., Proc., 1893, part i, pp. 174–180.

Describes pimelite, asbeferrite, cacoxenite, amphibolite, phonolite, and granulite from various parts of Pennsylvania.

354 **Gorby** (S. S.). Limits of natural gas supply.

Eng. Mag., vol. v, pp. 419–426.

Discusses the evidences which indicate the organic origin of natural gas.

355 —— Geology of Miami County, Indiana.

Ind. Dept. Geol. and Nat. Hist., 16th Rept., 1888, pp. 165–188.

Describes the topographic features of the county, the character of the drift mantle and the Devonian and Silurian limestones, and gives sections displayed by various gas wells.

356 —— Natural gas and petroleum.

Ind. Dept. Geol. and Nat. Hist., 16th Rept., 1888, pp. 189–301.

In tabular form gives the thicknesses of the Paleozoic formations found in Indiana. Discusses the origin of natural gas, its permanency of supply, and the theories concerning the structural conditions necessary for its accumulation. Includes a description of the structural features of the State and numerous sections as shown by well borings.

357 **Gordon** (C. H.). Quaternary geology of Keokuk, Iowa, with notes on the underlying rock structure.

Am. Geol. vol. ix, pp. 183–190, three sections.

Gives a vertical section of the beds at this locality. Describes the glacial deposits and loess formation in this region.

358 **Graham** (James C.). Some experiments with an artificial geyser.

Am. Jour. Sci., 3d ser., vol. xlv, pp. 54–60.

Describes the apparatus used and refers to McKenzie's theory of a geyser eruption. Gives tables showing the temperature of materials used, time of eruptions, etc., and discusses the results obtained as bearing on the phenomena of soaping geysers.

359 **Grant** (Ulysses Sherman). The stratigraphic position of the Ogishke conglomerate of northeastern Minnesota.

Am. Geol., vol. ix, pp. 4–10.

Describes the composition of the conglomerate and quotes the views of other writers on its age. Describes the relations of the conglomerate to the Saganaga granite and to the Keewatin. Concludes that it is not a parallel of the Animike and that it is a part of but younger than most of the Keewatin.

360 —— Note on an augite soda-granite from Minnesota.

Am. Geol., vol. xi, pp. 383–388.

Describes the petrographic characters and gives the chemical composition of a type of granite from the Precambrian of northeastern Minnesota.

361 —— Note on quartz-bearing gabbro in Maryland.

Johns Hopkins Univ. Circ., vol. xii, pp. 47–49.

Abstracts: Am. Geol., vol. xi, p. 209, (⅓ p.); Am. Nat., vol. xxvii, p. 383, (⅓ p.).

Describes the petrographic characters of certain quartz gabbros of Maryland.

362 —— Field observations on certain granitic areas in northeastern Minnesota.

Minn. Geol. and Nat. Hist. Surv., 20th Ann. Rept., pp. 35–110.

Gives field observations in different areas of the region, containing statements as to the general rock structures and a catalogue of specimens collected.

363 **Gregory** (J. W.). The relations of the American and European echinoid faunas.

Geol. Soc. Am., Bull., vol. iii, pp. 101–108.

Describes the characteristics of these faunas on the two continents, from the Carboniferous to and including the Tertiary, and concludes that their succession presents a series of phenomena incompatible with the theory of the permanence of the great ocean basins.

364 **Gresley** (W. S.). A hitherto undescribed phenomenon in hematite.

Am. Geol., vol. ix, pp. 219–223.

Discusses the origin of certain holes in a specimen of hematite.

365 —— Faulting in veins.

Eng. and Min. Jour., vol. liii, p. 517 and p. 660 (correspondence).

Describes an occurrence of coal which shows from the vein material that there has been a movement of the walls inclosing it.

366 —— North American geological notes.

Manchester Geol. Soc., Trans., vol. xxi, part ii, pp. 68–74.

Includes notes on some peculiar formations in the roof of a coal seam in Illinois, the occurrence of fossil trees in Pennsylvania anthracite beds and on some bowlders found in Coal Measures in the North American anthracite region.

367 **Grimsley** (G. Perry). Microscopical study of Ohio limestones.

Cin. Soc. Nat. Hist. Jour., vol. xv, pp. 160–167.

Describes the limestone formations of the State, their microscopic structure and the characters of some of the contained fossils.

368 **Griswold** (Leon S.). The structure of the Ouachita uplift of Arkansas.

Abstract: Am. Assoc. Adv. Sci. Proc., vol. xl, p. 261.

The uplift is formed of closely folded Silurian strata between two broad belts of Lower Carboniferous rocks, and appears to form a continuation of the Appalachian system.

369 —— A basic dike in the Connecticut Triassic.

Harv. Mus. Comp. Zool., Bull., vol. xvi, pp. 239–242.

Gives a brief description of the locality of the dike and the microscopic characters of the dike rock (fourchite ?), and discusses the question as to the class to which it belongs.

370 —— Whetstones and novaculites of Arkansas.

Ark. Geol. Surv., Ann. Rept., 1890, vol. iii, pp. 1–443, pls. i–ix.

Abstracts: Am. Jour. Sci., 3d ser., vol. xliv, p. 332 (½ p.); Am. Nat., vol. xxvii, p. 42 (½ p.).

Gives a general historical sketch of whetstones. Describes the megascopic and microscopic characters of Arkansas novaculites, their chemical composition and the topography and geology of the Arkansas novaculite area. Discusses their origin.

370*a* **Guiterman** (Franklin). [Origin of ore deposits.]

Col. Sci. Soc., Proc., vol. iv, pp. 347–348.

In discussion of paper by P. H. van Diest on the "Evidence bearing on the formation of ore deposits by lateral secretion."

371 **Gulliver** (F. P.). The Newtonville sand plain.

Jour. of Geol., vol. i, pp. 803–812.

Abstract: Am. Geol., vol. xii, p. 177 (¼ p.).

Describes the process of making the clay model of the map of the region, reproduced in fig. 1; and of another clay model of the supposed relations of the deposits, shown in fig. 2. Describes the origin and relations of the glacial beds.

372 **Gurley** (R. W.). The geologic age of the graptolite shales of Arkansas.

Ark. Geol. Surv., Ann. Rept., 1890, vol. iii, pp. 401–404.

Discusses the evidences presented by the fossils found in these shales in their bearing on the geologic age of the formation and their correlation with other beds of similar horizons, viz., the Trenton and Calciferous.

373 —— New species of graptolites.

Ark. Geol. Surv., Ann. Rept., 1890, vol. iii, pp. 416–418.

Brief description of new species from Arkansas.

374 **Gurley** (Wm. F. E.), **Miller** (S. A.) and. Description of some new genera and species of Echinodermata from the Coal Measures and sub-Carboniferous rocks of Indiana, Missouri, and Iowa.

Ind. Dept. Geol. and Nat. Hist., 16th Rept., 1888, pp. 327–373.

Describes new species of Echinodermata from the Carboniferous.

H.

375 **Hague** (Arnold). Geology of the Eureka district, Nevada.

U. S. Geol. Surv., Monograph XX, pls. i–viii, figs. 1–9.

Abstracts: Am. Geol., vol. xii, pp. 264–266; Am. Jour. Sci., 3d ser., vol. xlv, pp. 161–163.

Describes the topographic and geologic features of the region and includes a discussion of the relations of land and water during Paleozoic time. Gives an account of volcanic action in this region and a description of the ore bodies and their mode of formation. Appendix A gives a list of fossils found in each formation and Appendix B is a discussion of the microscopic characters of the crystalline rocks.

376 **Hall** (Charles E.). Geological notes on the manganese ore deposit of Crimora, Va.

Am. Inst. Min. Engrs., Trans., vol. xx, pp. 46–49.

The ore bodies lie in a basin at the base of the mountains formed of Potsdam sandstones, shales, and slates, in the former of which black oxide of manganese is disseminated and from which the ore appears to have been derived by seepage of surface waters.

377 —— The formation and deformation of Minnesota lakes.

Sci. Amer. Suppl., vol. xxxvi, pp. 14625–14626.

Describes the process of formation and deformation of the glacial lakes in Minnesota.

378 —— A review of the theories of the origin of the granitic rocks and the crystalline schists.

Abstract: Minn. Acad. Nat. Sci., Bull., vol. iii, p. 175.

Brief résumé of the theories of the origin of granite and allied rocks.

379 —— A vacation trip into the Black Hills of South Dakota.

Abstract: Minn. Acad. Nat. Sci., Bull., vol. iii, pp. 185–186.

Gives an account of the relations of the formations in this region.

380 —— The deep well at Minneota, Minn.

Minn. Acad. Nat. Sci., Bull., vol. iii, pp. 248–250.

Brief description of the formations penetrated, and gives the section as shown by the well record.

381 —— Notes on a geological excursion into central Wisconsin.

Minn. Acad. Nat. Sci., Bull., vol. iii, pp. 251–268.

Describes the microscopic and megascopic characters of the rock types in the region visited.

382 —— and **Sardeson** (F. W.). Paleozoic formations of southeastern Minnesota.

Geol. Soc. Am., Bull., vol. iii, pp. 331–368.

Abstracts: Am. Nat., vol. xxvii, p. 144; Am. Geol., vol. x, pp. 182–183 (⅓ p.).

Describes the character of the Archean floor upon which the Upper Cambrian was deposited and the lithologic characters of the Magnesian series. The Lower Silurian is represented by the St. Peters sandstone, Trenton and Cincinnati limestones and shales, and the Devonian by siliceous limestones containing few fossils.

383 **Hall** (James). An introduction to the study of the genera of Paleozoic Brachiopoda, part i. Assisted by J. M. Clarke.

Nat. Hist. of N. Y. Paleontology, vol. viii, part i, pp. 1–367, pls. i–xx.

Describes genera and also some of the species of Brachiopoda.

384 —— An introduction to the study of the genera of Paleozoic Brachiopoda. Assisted by J. M. Clarke.

Nat. Hist. of N. Y. Paleontology, vol. viii, part ii, fascicle i, pp. 1–176.

Continues the review of the genera of Paleozoic Brachiopoda begun in part i.

385 —— An introduction to the study of Brachiopoda.

N. Y. State Mus., 45th Ann. Rept., pp. 455–616.

Abstracts: Am. Geol., vol. x, pp. 251–253; Am. Jour. Sci., 3d ser., vol. xliv, pp. 330–332.

Describes the general characters of the class, their habits of life and powers of locomotion, and includes a description of some of the genera.

386 —— Report of the State Geologist for the year 1891.

N. Y. State Mus., 45th Ann. Rept., pp. 323–345.

Gives a list of Devonian fossils found in the Livonia salt shaft.

387 **Hall** (W. S.). The South Dakota artesian basin.

Science, vol. xxii, pp. 29–30.

Discusses and illustrates by cross section the geology of South Dakota.

388 **Hallock** (William). Preliminary report of observations at the deep well at Wheeling, W. Va.

Am. Jour. Sci., 3d ser., vol. xliii, pp. 234–236.

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xl, pp. 257–259.

Gives a list of temperatures at various depths down to 4,500 feet, and a table of comparison with those of two other deep wells.

389 **Halse** (Edward). Notes on the occurrence of manganese ore near Mulegé, Baja California, Mexico.

North of Eng. Inst. of Min. and Mech. Engrs., Trans., vol. xli, pp. 202–307.

Abstract: Eng. and Min. Jour., vol. lv, pp. 223–225.

Describes veins of manganese ore in trachyte and gives chemical analyses of some specimens. The ore occurs as filling of superficial vein-like fissures and was probably derived from the trachyte by leaching.

390 **Harker** (Alfred). Thermometamorphism in igneous rocks.

Geol. Soc. Am., Bull., vol. iii, pp. 16–22.

Refers to the previous publication on this subject and describes the changes in the igneous rocks of the English lake district. Concludes that basic and intermediate lavas, when affected by weathering, are as easily changed by heat as argillaceous sediments; acid lavas and ashes may be very little modified by heat. Various feldspars, resulting from the rejuvenation of old feldspars or by recombinations of other minerals in the advanced stages of metamorphism, are abundant in the newly formed products.

391 **Harker** (Alfred). On the migration of material during the metamorphism of rock masses.

Jour. of Geol., vol. i, pp. 574–578.

Discusses the changes in rock masses which are due to thermal metamorphism. Considers that transference of material due to thermal causes is confined to narrow limits and this limit varies with the temperature.

392 **Harris** (Gilbert Dennison). The Tertiary geology of Calvert Cliffs, Maryland.

Am. Jour. Sci., 3d ser., vol. xlv, pp. 21–31.

Gives the sections exposed by these cliffs at several localities, with a list of species found in each and map of the region.

393 —— Preliminary report on the organic remains obtained from a deep well at Galveston, together with conclusions respecting the age of the various formations penetrated.

Texas Geol. Surv., 4th Ann. Rept., pp. 117–119.

Gives in tabular form the bathymetric distribution of the fossils obtained from the well, from which the conclusions are drawn as to the geologic horizons represented, which are said to range from Pleistocene to Upper Miocene.

394 —— Correlation of Tejon deposits with Eocene stages of the Gulf Slope.

Science, vol. xxii, p. 97 (correspondence).

Remarks on similarity of the fauna found in the Eocene of the Gulf States, Texas, and California.

395 —— Republication of Conrad's fossil shells of the Tertiary formations of North America.

Abstract: Am. Geol., vol. xii, pp. 60–61.

395*a* —— **Dall** (W. H.) and. Correlation Papers. Neocene.

See Dall (W. H.) and Harris (G. D.), 216.

395*b* —— **Dumble** (E. T.) and. The Galveston deep well.

See Dumble (E. T.) and Harris (G. D.), 274.

396 **Harris** (T. W.). Mount Bob, Mount Ida, or Snake Hill.

Am. Jour. Sci., 3d ser., vol. xliii, pp. 236–238.

Describes the formations of this hill in eastern New York as remnants of the Lower Helderberg group.

396*a* **Harrison** (J. B.), **Jukes-Brown** (A. J.) and. The geology of Barbados, part ii. The oceanic deposits.

See Jukes-Brown (A. J.) and Harrison (J. B.), 508.

397 **Hartwell** (E. Adams). The Pearl Hill pothole.

Boston Soc. Nat. Hist., Proc., vol. xxv, pp. 421–425.

Describes the pothole as occurring in a bowlder of mica schist derived from a neighboring exposure of the same rock. Considers that it was formed by some glacial stream flowing down a crevasse.

398 **Hatcher** (J. B.). The Titanotherium beds.

Am. Nat., vol. xxvii, pp. 204–221.

Describes the geographic distribution of these beds, their lithologic composition and stratigraphic position, and discusses the character of the fauna by which they have been divided into lower, middle, and upper beds.

399 **Hatcher** (J. B.). The Ceratops beds of Converse County, Wyo.

Am. Jour. Sci., 3d ser., vol. xlv, pp. 135-144.

Describes the geographic distribution of the Ceratops beds in this region, the lithologic character of the strata, and their stratigraphic position. Discusses the age of the Ceratops beds, as indicated by the fossils, and the probable conditions attending their deposition.

400 **Haworth** (Erasmus). The age and origin of the crystalline rocks of Missouri.

Mo. Geol. Surv., Bull. No. 5.

Review: Am. Geol., vol. ix., pp. 55–56 (⅔ p.).

This paper is principally devoted to giving the evidence of the eruptive origin of the crystalline rocks of Missouri, and adds confirmatory evidence of their assumed Archean or Prepaleozoic age.

401 —— Prismatic sandstone from Missouri.

Science, vol. xix, p. 58; Iowa Acad. Sci., Proc., vol. i, part ii, pp. 36–37.

Describes an occurrence of sandstone of a prismatic form resembling basaltic columns.

402 —— Notes on Missouri minerals.

Iowa Acad. Sci., Proc., vol. i, part ii, pp. 33–35.

Describes occurrences of melanite in a basic dike rock and of limonite pseudomorphs after calcite.

403 **Hay** (Robert). Geology and mineral resources of Kansas.

Kans. State Board of Agric., 8th Biennial Rept., 1891–92, pp. 99–162.

Describes the topographic features and lithologic character and the relations of the Carboniferous, Cretaceous, Tertiary and Post-Tertiary formations in the State, including an account of the lead and zinc, coal, salt, and other mineral deposits.

404 —— Notes on some new species of fossil cephalopods.

Kans. Acad. Sci., Trans., vol. xiii, pp. 37–47.

Description of species occurring in the Carboniferous and Permo-Carboniferous of Kansas.

405 —— Some characteristics of the glaciated area of northeastern Kansas.

Kans. Acad. Sci., Trans., vol. xiii, pp. 104–106.

Describes the glacial deposits and phenomena of this region.

406 —— Sandstone dikes in northwestern Nebraska.

Geol. Soc. Am., Bull., vol. iii, pp. 50–55, figs. 1–5.

Briefly describes the geologic formations of the region and states the width and direction of the two dikes.

407 —— A contribution to the geology of the Great Plains.

Geol. Soc. Am., Bull., vol. iii, pp. 519–521.

Abstract: Am. Geol., vol. xi, pp. 56–57.

The surface of the plains area consists of calcareous and arenaceous clays of Tertiary age which may grade into Post-Pliocene to the east.

408 **Hayes** (C. W.). An expedition through the Yukon district.

Nat. Geog. Mag., vol. iv, pp. 117–159.

Describes the character of the country traversed and its general orographic features. The sedimentaries are limestones, shales, sandstones, quartzites, and conglomerates. The igneous rocks are mainly basic, largely altered to serpentine, and granites. Placer gold is widely disseminated and copper occurs at several localities. Describes the recent volcanic phenomena and the general features of the glaciation of the region.

409 —— Notes on the geology of the Yukon basin.

Abstracts: Geol. Soc. Am., Bull., vol. iii, pp. 495–496; Am. Geol., vol. xi, pp. 58–59 (⅓ p.).

410 —— Report on the geology of northeastern Alabama and adjacent portions of Georgia and Tennessee.

Ala. Geol. Surv., Bull. No. 4, pp. 11–85, pl. i, map and structure sections, figs. 1–15.

Abstracts: Jour. of Geol., vol. i, pp. 98–99; Am. Nat., vol xxvii, pp. 34–35 (½ p.); Am. Geol., vol. x, pp. 322–323 (½ p.).

Describes the topographic features of the district, its drainage systems, the stratigraphy of the Cambrian, Silurian, Devonian, and Carboniferous strata and their structural relations.

411 —— Chattanooga sheet. (Tennessee.)

U. S. Geol. Surv., Geol. map of the U. S., Preliminary edition, 1892.

Describes the topography of the area, the character and relations of the Cambrian, Silurian, Devonian, and Carboniferous formations, their structure, and the mineral resources. Accompanied by topographic, colored areal and economic and structure section maps and a sheet of columnar sections.

412 —— Kingston sheet. (Tennessee.)

U. S. Geol. Surv., Geol. map of the U. S., Preliminary edition, 1892.

Describes the topography of the area, the character, structure, and relations of the Cambrian, Silurian, Devonian, and Carboniferous rocks, the mineral resources and soils. Accompanied by topographic, colored areal and economic geologic and structure section maps.

413 ——Ringgold sheet. (Tennessee and Georgia.)

U. S. Geol. Surv., Geol. map of the U. S., Preliminary edition, 1892.

Describes the topography of the region, the stratigraphy of the Cambrian, Silurian, Devonian, and Carboniferous rocks, their structure and mineral resources. Accompanied by topographic, colored areal and economic geologic and structure section maps.

414 —— Bauxite.

U. S. Geol. Surv., Min. Res., 1893, pp. 159–167.

Describes the geologic structure of the Cambrian and Silurian formations in which the deposits are found in the Appalachian province and the forms of the ore bodies, and discusses their origin.

414*a* —— **Willis** (B.) and. Conditions of Appalachian faulting.

See Willis (B.) and Hayes (C. W.), entry 1060.

415 **Headden** (William P.). Kehoeite, a new phosphate from Galena, Lawrence County, South Dakota.

Am. Jour. Sci., 3d ser., vol. xlvi, pp. 22–25.

Describes the mineralogic characters and chemical composition of a new substance for which the name kehoeite is proposed. Includes a note on jarosite.

416 **Headden** (William P.). Stannite and some of its alteration products from the Black Hills, S. Dak.

Am. Jour. Sci., 3d ser., vol. xlv, pp. 105–110.

Describes the megascopic characters of a specimen found in a mine, containing mica. Gives a description of the alteration products and a chemical analysis of the mineral.

417 **Heilprin** (Angelo). The geology and paleontology of the Cretaceous deposits of Mexico.

Review: Am. Geol., vol. x, p. 121 (½ p.).

Noticed in Record for 1891.

418 **Heinrich** (Carl). Zinc-blende mines and mining near Webb City, Missouri.

Am. Inst. Min. Engrs., Trans., vol. xxi, pp. 3–25.

Abstract: Eng. and Min. Jour., vol. liii, pp. 594–595.

The ore bodies occur in Subcarboniferous limestones, overlaid by bituminous clay, calcareous slates and shales, and are found at intervals over a considerable area. Describes the character and structure of the ore deposits.

419 **Henderson** (C. Hanford). Mica and mica mines.

Eng. and Min. Jour., vol. lv, p. 4.

Describes briefly the general characteristics and manner of occurrence of mica, with remarks on the mica veins of North Carolina.

420 **Hershey** (Oscar H.). The Utica shale in Stephenson County, Illinois.

Science, vol. xxii, p. 202.

Gives a generalized section of the Cincinnati group of this county, and describes its lithologic characteristics.

421 —— The Pleistocene rock gorges of northwestern Illinois.

Am. Geol., vol. xii, pp. 314–323.

Describes the rock gorges of this region and discusses the cause of their formation. Includes an account of the gorge cutting during the glacial period.

422 **Herzer** (H.). A new fungus from the Coal Measures.

Am. Geol., vol. xi, pp. 365–366.

Describes the fungus found in Zoar limestone, Tuscarawas County, Ohio.

423 —— A new tree from the Carboniferous rocks of Monroe County, Ohio.

Am. Geol., vol. xi, pp. 285–286.

Describes a new genus and species of Endogen.

424 —— A new fungus from the Coal Measures.

Am. Geol., vol. xii, pp. 289–290.

Describes a new fungus from Ohio.

425 **Hicks** (Lewis Ezra). Some elements of land sculpture.

Geol. Soc. Am., Bull., vol. iv, pp. 133–146.

Abstract: Am. Geol., vol. xi, p. 412, 6 l.

Discusses some principles of erosion processes.

426 —— The evolution of the Loup rivers in Nebraska.

Science, vol. xix, pp. 59 and 137.

Describes briefly the topographic features of the region.

427 **Hicks** (Lewis Ezra). Readjustments of the Loup rivers; examples of abstraction due to unequal declivities.

Science, vol. xix, pp. 288–290.

Discusses the question of the efficiency of abstraction to account for the capture of one stream by another and the changes which have taken place in the courses of the Loup rivers.

428 —— The geological structure and surface features of the region drained by the Loup rivers.

Neb. State Board of Agric., Ann. Rept. for 1892, pp. 337–359.

Describes the topographic features and the general character of the Tertiary beds of the Loup region.

429 **Hidden** (William Earl). On mackintoshite, a new thorium and uranium mineral; with analyses by W. F. Hillebrand.

Am. Jour. Sci., 3d ser., vol. xlvi, pp. 98–103.

Describes a new mineral from Texas and gives the chemical analyses of the material and a discussion of the composition.

430 —— Mineralogical notes.

Am. Jour. Sci., 3d ser., vol. xlvi, pp. 254–257.

Describes xenotime from North Carolina and jarosite from New Mexico.

431 —— and **Hillebrand** (W. F.). Description of rowlandite.

Am. Jour. Sci., 3d ser., vol. xlvi, pp. 208–212.

Describes the mineralogic characters of rowlandite from Llano County, Tex., including chemical analyses and a discussion of composition.

432 **Hilgard** (Eugene W.). The age and origin of the Lafayette formation.

Am. Jour. Sci., 3d ser., vol. xliii, pp. 389–402.

Describes the beds as being predominately a ferruginous sand and the structure similar to that resulting from running and violently agitated waters. Extensive erosion preceded and followed its deposition. Discusses the evidence as to its geologic age and attributes the formation to a perion of high elevation, greater in northern latitudes.

433 —— The Cienegas of southern California.

Geol. Soc. Am., Bull., vol. iii, pp. 124–127.

Describes cienegas found in this region and the formations of which they are composed. Discusses their economic importance as a source of water supply.

434 —— Die Bodenverhältnisse Californiens.

Zeit. Deut. geol. Gesell., Band xlv, Heft 1, 1893, pp. 15–22.

Describes the general topographic and geologic features of California and discusses the evidence bearing on the character and extent of the various orographic movements.

435 **Hill** (R. T.). Paleontology of the Cretaceous formation of Texas. The invertebrate paleontology of the Trinity division.

Wash. Biol. Soc., Proc., vol. viii, pp. 9–40, pls. i–viii.

Reviews the literature on the stratigraphic divisions and nomenclature of the Comanche series. Describes the position and characteristics of the Trinity division. Discusses the general characters of the Trinity fossils and the age and significance of the Trinity beds, gives a list of fossils found in them and describes some of the species.

436 **Hill** (R. T.). The paleontology of the Cretaceous formation of Texas. The invertebrate fossils of the Caprina limestone beds.

Wash. Biol. Soc., Proc., vol. viii, pp. 97–108, pls. xii-xiii.

Describes the stratigraphic position of the Caprina limestone in the Comanche series, gives a list of characteristic fossils, discusses the age of the beds, and describes some of the species found in the Caprina limestone.

437 —— The occurrence of hematite and martite iron ores in Mexico.

Am. Jour. Sci., 3d ser., vol. xlv, pp. 111-119.

Describes the geologic features of the Sierra de Mercado Mountain, in which the iron ore occurs, the occurrence of the ore bodies, and the chemical composition of the ore. Includes brief description of the iron ore bodies in other portions of Mexico occurring in rocks of Cretaceous and Tertiary age.

438 —— The Cretaceous formations of Mexico and their relations to North American geographic development.

Am. Jour. Sci , 3d ser., vol. xlv, pp. 307–324.

Abstract: Am. Nat., vol xxvii, pp. 657–658.

Classifies the formations into four groups and describes the lithologic character and structure of the Cretaceous. Discusses the age and homotaxial relations of the Comanche series, the extent and history of its sedimentation, and includes a table showing the known positions of the Comanche series and related formations in Mexico.

439 —— The deep artesian boring at Galveston, Tex.

Am. Jour. Sci., 3d ser., vol. xliv, pp. 406–409.

Gives the vertical section as shown by the boring, which shows, by the absence of consolidated material, that the beds are Post-Cretaceous. Sedimentation took place in shallow water, and it is considered that the total subsidence of the Eocene shore line has been about 3,000 feet.

440 —— Notes on the Texas-New Mexican region.

Geol. Soc. Am., Bull., vol. iii, pp. 85-100.

Describes the remnant of Eocene occurring in this region and its relations to the mountains and plains area. Includes description of the other geologic formations and the volcanic area of eastern New Mexico.

441 —— The geologic evolution of the non-mountainous topography of the Texas region. An introduction to the study of the Great Plains.

Am. Geol., vol. x, pp. 105–115.

Gives a general statement concerning the topographic features at the close of the Paleozoic. Describes the processes of elevation and subsidence during Mesozoic and Tertiary times and the formation of the drainage systems during and since the close of the Tertiary.

442 —— Mexico as an iron-producing country.

Eng. Mag., vol. iv, pp. 744–753.

Describes the occurrence of the iron ores of Moncliva and those in the States of Jalisco and Guerero.

443 **Hill** (R. T.). On the occurrence of artesian and other underground waters in Texas, eastern New Mexico, and Indian Territory west of the ninety-seventh meridian.

Final Report of the Artesian and Underflow Investigation, part iii, Govt. Print. Office, Washington, 1892.

Abstracts: Am. Jour. Sci., 3d ser., vol. xliv, p. 333 (⅓ p.); Am. Nat., vol. xxvi, pp. 935-936.

Describes the general topographic and geologic features of the southwest portion of the United States, including a more detailed account of the Cretaceous beds.

444 —— Tucumcari.

Science, vol. xxii, pp. 23-25 (correspondence).

Refers to the writer's previously published opinions on the geology of Tucumcari and gives a vertical section of the mesa and a list of fossils which indicate the beds are of Cretaceous age.

445 **Hillebrand** (W. F.). Zinc-bearing spring waters from Missouri.

Am. Jour. Sci., 3d ser., vol. xliii, pp. 418–422.

Describes the locality of the springs and gives chemical analyses of two samples.

445*a* —— **Hidden** (W. E.) and. Description of rowlandite.

See Hidden (W. E.) and Hillebrand (W. F.), 430.

446 **Hills** (R. C.). Coal fields of Colorado.

U. S. Geol. Surv., Min. Res., 1892, pp. 319-365.

The Coal Measures are of Upper Cretaceous age. The character of the coal shows great variations dependent on certain structural conditions and on the intrusion of eruptive masses. Describes the geographic and stratigraphic features of the various coal fields and gives analyses of the coals.

446*a* **Hills** (R. C.) Denver artesian basin.

Colo. Sci. Soc., Proc., vol. iv, p. 6 (½ p.).

In discussion of paper by P. H. van Diest, "On the artesian wells of Denver."

446*b* —— Remarks on the classification of the Huerfano Eocene.

Colo. Sci. Soc., Proc., vol. iv, pp. 7–9.

Refers to the author's former classification of these beds and discusses the evidences on which this classification is based.

446*c* —— Types of past eruptions in the Rocky Mountains.

Colo. Sci. Soc., Proc., vol. iv, pp. 14–32.

Includes brief remarks on the Pretertiary and Cenozoic eruptions in this region. Describes the structure of the Sangre de Christo, Henry, and La Plata mountains and the Spanish Peaks as being formed by intrusive bodies, and of the San Juan Mountains, the White River Plateau, Raton and Uinkaret mountains and Mount Taylor as being made up of extrusive bodies. Gives a table of the intrusive, extrusive, and tufaceous rocks, and describes briefly their distribution.

446*d* —— Twin crystals of selenite.

Colo. Sci. Soc., Proc., vol. iv, p. 32 (⅛ p.).

Brief note on the crystallographic character of selenite crystals said to have been found in a cave near Fort Stanton, N. Mex.

446*e* **Hills** (R. C.) [Post-Laramie beds of Middle Park, Colorado.]

Colo. Sci. Soc., Proc., vol. iv, pp. 213–214.

In discussion of paper by Whitman Cross on the same subject.

446*f* —— [Origin of ore deposits.]

Colo. Sci. Soc., Proc., vol. iv, pp. 351–353.

In discussion of paper by P. H. van Diest on the "Evidence bearing on the formation of ore deposits by lateral secretion."

447 **Hitchcock** (C. H.). Terminal moraines in New England.

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xli, pp.173–175.

Locates the line of terminal moraines as determined by the author.

448 —— Studies of the Connecticut Valley glacier.

Geol. Soc. Am., Bull.. vol. iv., pp. 3–4.

Describes certain glacial phenomena in this region.

449 —— The Green Mountains anticlinal.

Science, vol. xx, p. 328.

Reviews previous publications on the geology of the Green Mountains. Describes the rock structure and relations to the anticlinal structure.

450 **Hobbs** (William H.). Notes on some pseudomorphs from the Taconic region.

Am. Geol., vol. x, pp. 44–48.

Describes briefly the microscopic character and chemical composition of the minerals and the rocks in which they were found in Connecticut.

451 —— New occurrence of parallel intergrowths of the minerals allanite and epidote.

Am. Geol., vol. xii., pp. 218–219.

Mentions several occurrences of this structure and refers specially to its occurrence in Maryland granites, described by C. R. Keyes.

452 —— Phases in the metamorphism of the schists of southern Berkshire.

Geol. Soc. Am., Bull., vol. iv., pp. 167–178.

Abstracts: Am. Geol., vol. xi, pp. 273–274 (½ p.); Am. Nat. vol. xxvii, p. 1087.

Describes the beds represented in the area and the origin and structure of the porphyritic constituents of the schists, and concludes that they originally formed part of a clastic rock and that the present structure is due to its partial recrystallization.

453 —— Secondary banding in gneiss.

Geol. Soc. Am., Bull., vol. iii, pp. 460–464.

Abstract: Am. Geol., vol, xi, pp. 59–60 (⅛ p.).

The secondary banding consists of straight banding parallel to the foliation and is due to an alternation of layers of different mineral composition, which gives the rock the appearance of ordinary sedimentation.

454 —— On some metamorphosed eruptives in the crystalline rocks of Maryland.

Wis. Acad. Sci. Arts and Letters, Proc., vol. viii, pp. 156–160, pl. 1, figs. 1–3.

Gives an example of the metamorphism of gabbro into hornblende-gneiss and describes the general characteristics of the rock structures and their modifications in the vicinity of Baltimore.

455 **Hobbs** (W. H.). Note on cerussite from Illinois and Wisconsin.

Wis. Acad. Sci. Arts and Letters, Proc., vol. viii, pp. 399–400.

Gives crystallographic measurements of certain specimens.

456 —— On the geological structure of the Mount Washington mass of the Taconic range.

Jour. of Geol., vol. i, pp. 717–736.

Reviews the previous work within the area and describes the lithologic characters of the four subdivisions of the Silurian represented. Explains the areal geologic map and sections illustrating the structure of the mountain mass.

457 —— The geological structure of the Hoosatonic Valley lying east of Mount Washington.

Jour. of Geol., vol. i, pp. 780–802.

Refers to the literature concerning the region. Describes the lithologic characters of the Silurian strata and the geologic structure of the area, illustrated by map and sections, with a description of the great Hoosatonic fault.

458 —— On intergrowth of hornblende with augite in crystalline rocks.

Science, vol. xx, p. 354.

Gives results of some recent observations.

458*a* —— **Culver** (G. E.) and. On a new occurrence of olivine diabase in Minnehaha County, S. Dak.

See Culver (C. E.) and Hobbs (W. H.), 199.

459 **Hobson** (J. B.) and **Wiltsee** (E. A.). Nevada County.

Cal. State Min. Bur., 11th Rept., pp. 263–318.

Describes briefly the geologic features of the Grass Valley district, with notes on some of its mines, and the Nevada City mining district, with notes on the quartz and drift gravel mines, and includes notes on mines in other mining districts in this county.

460 **Hodson** (W. G.). Shasta County.

Cal. State Min. Bur., 11th Rept., pp. 395–399.

Notes on some of the gold mines.

461 **Hodge** (James M.). The Big Stone Gap coal field.

Am. Inst. Min. Engrs., Trans., vol. xxi, pp. 922–938 and 1005–1006.

Abstract: North of Eng. Inst. of Min. and Mech. Engrs., Trans., vol. xliii, part vi, appendices, p. 39 (¼ p.).

Describes the geology of the region, illustrated by sections of Little and Big Black Mountain and the geologic position of the different coal beds, with a statement as to the character of the coal found in each bed.

462 **Hoffman** (G. Christian). Chemical contributions to the geology of Canada from the laboratory of the Survey.

Can. Geol. Surv., Reports, vol. v, new series, Part II, 1890–91, Report R, p. 72.

Abstract: Am. Jour. Sci., 3d ser., vol. xlv, pp. 75–76.

Gives the locality from which each specimen was obtained and the chemical analysis of each of the different minerals, natural waters and ores mentioned.

463 **Hollick** (A.). The paleontology of the Cretaceous formation on Staten Island.

N. Y. Acad. Sci., Trans., vol. xi, pp. 96–102.

Abstract: Am. Jour. Sci., 3d ser., vol. xliv, p. 259 (½ p.).

Gives a list of fossils found and describes the general character of the Cretaceous beds on this island.

464 —— Preliminary contribution to our knowledge of the Cretaceous formation on Long Island and eastward.

N. Y. Acad. Sci., Trans., vol. xi, pp. 222–237.

Reviews the literature on the Cretaceous of this region and describes plant remains found in Cretaceous clays.

465 —— Additions to the paleobotany of the Cretaceous formation on Staten Island.

N. Y. Acad. Sci., Trans., vol. xii, pp. 28–39.

Abstract: Am. Jour. Sci., 3d ser., vol. xlv, p. 437 (½ p.).

Describes plant remains from the Cretaceous of Staten Island.

466 —— Plant distribution as a factor in the interpretation of geological phenomena, with special reference to Long Island and vicinity.

N. Y. Acad. Sci., Trans., vol. xii, pp. 189–202.

Describes the flora of New York, New Jersey, and New England and its relation to the geology of the region.

467 —— Paleobotany of the Yellow gravel at Bridgeton, N. J.

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xli, pp. 177–178; Torr. Bot. Club, Bull., vol. xix, pp. 330–333.

468 —— A new fossil palm from the Cretaceous formation of Glen Cove, Long Island.

Torr. Bot. Club, Bull., vol. xx, pp. 168–169, pl. cxlix.

Describes Serenopsis kempii, n. gen.

468*a* **Hollick** (Arthur), **Kemp** (J. F.) and. The granite at Mounts Adam and Eve, Warwick, Orange County, N. Y.

See Kemp (J. F.) and Hollick (A.), 520.

469 **Holmes** (J. A.). Character and distribution of road materials.

Elisha Mitchell Sci. Soc., Jour., part ii, 1892, pp. 66–87.

Gives a table showing the coefficients of wear and crushing of different road materials. Describes those rocks which are suitable as road materials and their distribution in the Coastal Plain, Piedmont and Mountain regions of some of the Eastern and Southeastern States.

470 **Hopkins** (T. C.). The Eureka shale of northern Arkansas.

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xl, pp. 256–257.

The shale occurs between the Silurian and Carboniferous and is widely but unequally distributed. The interval was marked by a depression of such depth that but little sediment was deposited during Upper Silurian and Devonian times.

471 **Houser** (Gilbert L.). Some lime-burning dolomites and dolomitic building stones from the Niagara of Iowa.

Iowa Geol. Surv., 1st Ann. Rept., 1892, vol. i, pp. 199–207.

Describes the character and chemical composition of the limestone and its exposures at different localities.

472 **Hubbard** (George C.). The cystidians of Jefferson County, Indiana.
Ind. Acad. Sci., Proc., 1891, p. 67.
Brief reference to locality where these fossils are found.

473 —— Hudson River fossils of Jefferson County, Indiana.
Ind. Acad. Sci., Proc., 1891, p. 68.
Includes list of species from this horizon.

474 —— The upper limit of the Lower Silurian at Madison, Indiana.
Ind. Acad. Sci., Proc., 1891, pp. 68–70.
Statement concerning the fossil evidence which indicates the line between the Upper and Lower Silurian in this locality.

474*a* **Hubbard** (Lucius L.), **Koenig** (G. A.) and. On powellite from a new locality.
See Koenig (G. A.) and Hubbard (L. L.), 562.

475 **Hulst** (D.). The iron ore deposits of a portion of the Menominee range, Michigan.
Abstract: Eng. and Min. Jour., vol. lv, p. 366.

476 **Hunt** (Alfred E.). Aluminum.
U. S. Geol. Surv., Min. Res., 1892, pp. 227–254.
Describes the deposits from which aluminum ores are obtained, the metallurgical processes involved in its reduction, and the properties of aluminum.

476*a* **Huntington** (Oliver W.), **Kunz** (G. F.) and. On the diamond in the Canyon Diablo meteoric iron and on the hardness of carborundum.
See Kunz (F.) and Huntington (O. W.), 568.

477 **Hyatt** (Alpheus). Jura and Trias at Taylorsville, California.
Geol. Soc. Am., Bull., vol. iii, pp. 395–412.
Abstracts: Am. Nat., vol. xxvii, pp. 470–471; Am. Jour. Sci., 3d ser., vol. xliv, p. 330 (½ p.); Am. Geol., vol. x, p. 183 (⅓ p.).
Names many of the species found in the Jurassic and Triassic formations and compares them with similar European species. From the facts cited it appears that the Jura occurs only in widely separated areas and that the deposits of Mount Jura furnish a larger number of fragments of the Jurassic system than any other known locality in the United States.

478 —— Carboniferous cephalopods. Second paper.
Texas Geol. Surv., 4th Ann. Rept., pp. 379–474.
Describes the method used in determining generic characters and explains the meaning of terms used and the plate of diagrams used to explain the terms more fully. Describes the genera and species of cephalopods from the Carboniferous of Texas.

479 —— The fauna of Tucumcari.
Am. Geol., vol. xi, p. 281 (⅛ p.) (correspondence).
Refers to criticisms by Jules Marcou.

480 —— Remarks on the Pinnidæ.
Boston Soc. Nat. Hist., Proc., vol. xxv, pp. 335–346.
Gives a general description of the Pinnidæ

I.

481 **Iddings** (Joseph Paxson). A dissected volcano of Crandall basin, Wyoming.

Jour. of Geol., vol. i, pp. 606–611.

Describes the general geologic structure of the region and the petrographic characters of the volcanic rocks, with remarks on the degrees of crystallization shown in rocks which occurred at approximately the same depth beneath the volcano, viz., 10,000 feet or more.

482 —— Genetic relationships among igneous rocks.

Jour. of Geol., vol. i, pp. 833–844.

Describes the differences and gradations in chemical and mineralogic composition of different varieties of igneous rocks, the consanguinities of rocks of the same petrographic province, the peculiarities which may distinguish the rocks of one province from those of another, and the general principle of magmatic differentiation which govern the differences and consanguinities.

483 —— The origin of igneous rocks.

Washington Phil. Soc., Bull., vol. xii, pp. 89–214, pl. ii.

Abstracts: Am. Geol., vol. xii, pp. 124–125; Am. Jour. Sci., 3d ser., vol. xliv, pp. 257–258; Am. Nat., vol. xxvii, pp. 40–42.

Gives a historical review of the literature of the subject. Discusses the evidence indicating the consanguinity of igneous rocks, the character, cause and results of the differentiation of molten magmas and the localization of volcanic phenomena. Concludes that the consanguinity of the various rocks of a natural group is shown by their mineralogic, chemical, and geologic relationships, and that the differentiation of a common magma is established by the geologic occurrence and order of eruption of the members of the group, and that this differentiation is of a chemico-physical nature. Eleven tables of rock analyses.

484 —— The eruptive rocks of Electric Peak and Sepulchre Mountain, Yellowstone National Park.

U. S. Geol. Surv., 12th Ann. Rept., part i, pp. 577–664, pls. xlvi-liii.

Abstract: Am. Jour. Sci., 3d ser., vol. xliv, p. 429 (½ p.).

Gives a geologic sketch of the region. Describes the diorite, porphyrite, and dike rocks of Electric Peak and the andesite, dacite, and tuff of Sepulchre Mountain, and discusses their correlation and classification as igneous rocks.

485 —— Microscopical petrography of the eruptive rocks of the Eureka district, Nevada.

U. S. Geol. Surv., Monograph XX, Appendix B, pp. 337–396.

Gives a petrographic description of the eruptive rocks of the Eureka district, including granite, andesite, dacite, rhyolite, and basalt.

486 —— On a group of volcanic rocks from the Tewan Mountains, New Mexico, and on the occurrence of primary quartz in certain basalts.

U. S. Geol. Surv., Bull. No. 66.

Abstract: Am. Geol., vol. ix, pp. 264–265 (⅛ p.).

486*a* **Indiana, Dept. of Geol. and Nat. Resources,** Seventeenth Report.

Abstract: Am. Geol., vol. xi, p. 349 (⅛ p.).

487 **Ingall** (E. D.). On the cherts and domolites of the Animikie rocks of Thunder Bay, Lake Superior.

Can. Rec. Sci., vol. v, pp. 29–38.

Describes the character of the cherts and dolomites and states that they apparently form interchangeable members of the series. Describes microscopic characters of several specimens, which show the alteration to have been by chemical action, unaccompanied by the more powerful forces of metamorphism.

488 **Ingalls** (W. R.). Aluminum in the United States.

Abstract: North of Eng. Inst. of Min. and Mech. Engrs., Trans., vol. xlii, p. 388.

488*a* **Iowa Geological Survey**, First Annual Report, 1890.

Abstracts: Am. Nat., vol. xxvii, pp. 985–987; Am. Jour. Sci., 3d ser., vol. xlvi, pp. 397–398; Am. Geol., vol. xii, pp. 337–339; Jour. of Geol., vol. i, pp. 747–751.

489 **Irving** (Roland Duer) and **Van Hise** (C. R.). The iron-bearing series of Michigan and Wisconsin.

U. S. Geol. Surv., Monograph XIX, pls. i–xxxvii, figs. 1–12.

Gives an account of previous geologic explorations in this region and their literature. Describes the relations of the formations, their character and extent, and the microscopic characters of the rocks examined in thin sections, including granites of the southern complex, cherty limestones, quartz and actinolitic slates and diabases. Discusses the origin of the rocks of the iron-bearing members and the position and concentration of the ore bodies.

490 —— The Penokee iron-bearing series of Michigan and Wisconsin.

U. S. Geol. Surv., 10th Ann. Rept., part i, pp. 341–507.

Abstract: Am. Geol., vol. ix, pp. 207–208.

Noticed in Record of 1891.

J.

491 **James** (James F.). Manual of the Paleontology of the Cincinnati group.

Cin. Soc. Nat. Hist., Jour., vol. xiv, pp. 45–72, and 149-163, and vol. xv, pp. 88–100 and 144–159.

Locates and describes species found in this group.

492 —— The preservation of plants as fossils.

Cin. Soc. Nat. Hist., Jour., vol. xv, pp. 75–78.

Describes briefly some of the modes of the preservation of plants as fossils.

493 —— Studies in problematic organisms, No. II. The Genus Fucoides.

Cin. Soc. Nat. Hist., Jour., vol. xvi. pp. 62–81.

Reviews the previous literature on the definition and classification of fucoids and gives a list of species now recognized.

494 —— Remarks on the Genus Arthrophycus Hall.

Cin. Soc. Nat. Hist., Jour., vol. xvi, pp. 82–86.

Reviews the literature describing this fossil and the question as to its generic designation.

495 **James** (James F.). Fossil fungi.

Cin. Soc. Nat. Hist., Jour., vol. xvi, pp. 94–100.

Contains a translation of a portion of an article published in the Revue Mycologique, April, 1893, from the French of M. Ferry, with remarks upon other papers concerning fungoid bodies.

496 —— Studies in problematic organisms. The Genus Scolithus.

Geol. Soc. Am., Bull., vol. iii, pp. 32–44.

Abstract: Am. Nat., vol. xxvi, pp. 240–242.

Refers to previous descriptions of Scolithus and gives a list of species of this genus described from North America, and considers that from this its geologic range appears to be from the Lower Cambrian to the Triassic.

497 —— The Cincinnati ice dam.

Am. Geol., vol. xi, pp. 199–202.

Describes certain glacial phenomena which indicate the existence of an ice dam at this locality during the Glacial period.

498 —— On the age of the Point Pleasant, Ohio, beds.

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xl, pp. 283–284.

Reviews the opinions of other writers on the age of these beds. Describes the section at this point and considers there is no evidence to justify classifying them with the Trenton.

499 —— On problematic organisms and the preservation of algæ as fossils.

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xl, p. 284.

Considers that algæ are not included in the species referred to the class from lower rocks, and that the supposed tracks, trails, and burrows are more likely due to inorganic causes.

499*a* **Jefferis** (William W.), **Rand** (T. D.) and **Cardeza** (J. T. M.). Mineral localities of Philadelphia and vicinity.

See Rand (T. D.), Jefferis (W. W.) and Cardeza (J. T. M.), 771.

500 **Johnson** (Guy R.). Methods of working and surveying the mines of the Longdale Iron Company, Virginia.

Am. Inst. Min. Engrs., Trans., vol. xx, pp. 96–107.

This ore body is occasionally overlain by Helderberg limestone, and the latter is overlain by Devonian shale. Describes the method of opening the ground and of surveying the mines.

501 **Johnson** (Lawrence C.). The Grand Gulf formation.

Science, vol. xx, pp. 151 and 247.

Describes the Pascagoula embayment, and states that it is a branch of the great Mississippi embayment.

502 —— The Miocene group of Alabama.

Science, vol. xxi, pp. 90–91.

Describes the occurrence of Miocene strata at various localities in Alabama.

503 —— Notes on the geology of Florida; two of the lesser but typical phosphate fields.

Am. Jour. Sci., 3d ser., vol. xlv, pp. 497–503.

Describes the general character of the strata of Eocene and Miocene age, and the plate rock deposits, including a discussion as to the origin of the latter deposits.

504 —— The Chattahoochee embayment.

Geol. Soc. Am., Bull., vol. iii, pp. 128–133.

This embayment is an extension of the bay of Apalachee, and the deposits are very impure limestones. They form the base upon which lie the phosphates of the region. Gives sections of the beds at several localities.

505 **Jones** (Arthur J.). St. Louis limestone in Poweshiek County, Iowa.

Science, vol. xxii, p. 307 (correspondence).

Mentions the finding of exposures of St. Louis limestone in this county.

505*a* **Jones** (J. T.), **Winchell** (H. V.) and. The Biwabik mine.

See Winchell (H. V.) and Jones (J. T.), 1067.

506 **Jones** (T. Rupert). On some fossil Ostracoda from southwest Wyoming and from Utah, U. S. A.

Geol. Mag., dec. iii, vol. x, pp. 385–391.

Describes some species from the Cretaceous of Wyoming and Utah.

507 **Jordan** (E. T. J.). The gas area.

Ind. Dept. Geol. and Nat. Hist., 17th Rept., 1891, pp. 328–364.

Describes the general extent of the gas area in Indiana, the occurrence of gas, and the conditions which govern its production.

508 **Jukes-Browne** (A. J.) and **Harrison** (J. B.). The geology of Barbados. Part II. The oceanic deposits.

Geol. Soc. Quart. Jour., vol. xlviii, pp. 170–226.

Discusses the evidences of the submergence of the Caribbean region and Central America in Pliocene time and considers that there was free communication between the Atlantic and the Pacific during the late Tertiary.

K.

509 **Keith** (Arthur). The geologic structure of the Blue Ridge in Maryland and Virginia.

Am. Geol., vol. x, pp. 362–368.

The sedimentary rocks consist of the valley limestone and the shales and sandstones of the mountain region, the sequence being in the order given from the top downward. Describes the stratigraphic and structural relations of the igneous and sedimentary rocks.

510 —— Geology of Chilhowee Mountain in Tennessee.

Washington Phil. Soc., Bull., vol. xii, pp. 71–88, pl. i.

States that the structure is synclinal and the mountain is formed of the oldest sedimentary rocks. Discusses the lithologic evidences bearing on the age of the limestone series and the contact relations of the beds. Concludes that the Chilhowee-Knox interval indicates that the Appalachian folding and faulting began after the deposition of the first Paleozoic beds instead of the last.

511 **Kellogg** (D. S.). Glacial phenomena in northeastern New York.

Science, vol. xix, p. 341.

Describes some glacial deposits in this region.

512 **Kemp** (J. F.). The great shear-zone near Avalanche Lake, in the Adirondacks.

Am. Jour. Sci., 3d ser., vol. xliv, pp. 109–114.

Describes the region in which it occurs and the general mineralogic characteristics of the rock of the shear-zone and of the country rock.

513 **Kemp** (J. F.) A basic dike near Hamburg, Sussex County, N. J., which has been thought to contain leucite.

Am. Jour. Sci., 3d ser., vol. xlv, pp. 298–305.

Refers to descriptions of other elæolite-syenite areas.

Gives a map showing the geology of the region in which the dike occurs, describes its petrographic characters, and gives chemical analyses.

514 —— The classification of ore deposits.

School of Min. Quart., vol. xiv, pp. 8–24.

Reviews the methods of classification of ore deposits adopted by other writers and gives the author's classification.

515 —— The ore deposits of the United States.

The Scientific Publishing Company, New York, 1893.

Abstract: Am. Geol., vol. xii, pp. 268–269.

516 —— Notes on the Lower Coal Measures of western Clearfield County, Pa.

School of Min. Quart., vol. xiv, pp. 349–353.

Describes the geologic structure in this region and gives a vertical section showing the thicknesses of the coal seams and associated strata.

517 —— The elæolite-syenite near Beemerville, Sussex County, N. J.

N. Y. Acad. Sci., Trans., vol. xi, pp. 60–71.

Abstracts: Geol. Soc. Am., Bull., vol. iii, pp. 83–84; Am. Nat., vol. xxvii, pp. 272–273 (½ p.).

Describes the petrographic characters and chemical composition of the dike rock. Compares this rock with other elæolite-syenites.

518 —— A review of the work hitherto done on the geology of the Adirondacks.

N. Y. Acad. Sci., Trans., vol. xii, pp. 19–24.

Reviews the literature on the geology of the Adirondacks.

519 —— On the occurrence of gabbro (norite) near Van Artsdalen's quarry, Bucks County, Pa.

N. Y. Acad. Sci., Trans., vol. xii, p. 71.

Describes the petrographic characters of the specimens.

520 —— and **Hollick** (A.). The granite at Mounts Adam and Eve, Warwick, Orange County, N. Y., and its contact phenomena.

N. Y. Acad. Sci., Annals, vol. vii, pp. 638–650.

Describes the stratigraphic relations of the limestones of the region, the petrographic characters of the granite and limestone and their contact phenomena. Accompanied by geologic map and sections.

521 —— and **Marsters** (V. F.). The trap dikes of the Lake Champlain region.

U. S. Geol. Surv., Bull., No. 107. pp. 11–62.

Describes the general topographic and geologic features, the distribution of the dikes, the petrographic characters of the various dike rocks, including bostonite, breccia bostonites, diabases, camptonites, monchiquites, and fourchites, with chemical analyses, and discusses the geologic relations of the dikes at different localities.

522 **Kennedy** (W.). Report for 1891.

Texas Geol. Surv., 2d Rept. of Prog., 1891, pp. 55–69.

Describes the relations of the Cretaceous, Tertiary, and Quaternary strata of eastern Texas and the contained beds of salt, lignite, iron ores, building stones, and clays.

523 **Kennedy** (W.). Houston County [Texas].

Texas Geol. Surv., 3d Ann. Rept., 1891, pp. 7–40.

Describes the general geology of the county, including beds of Recent, Quaternary, Miocene, and Eocene formations; also the soils, iron ores, lignites, building stones, and clays.

524 —— A section from Terrell, Kaufman County, to Sabine Pass, on the Gulf of Mexico [Texas].

Texas Geol. Surv., 3d Ann. Rept., pp. 43–125.

Describes the Cretaceous, Eocene, Miocene, Pleistocene, and Recent deposits, and gives detailed sections at many localities.

525 —— Report on Grimes, Brazos, and Robertson Counties [Texas].

Texas Geol. Surv., 4th Ann. Rept., pp. 1–84.

Describes the topographic features of each of the counties named, the lithologic character of the Recent and Tertiary beds, giving the sections displayed at several localities, and includes a description of the soils, building stones, coal, and other economic resources of the region.

526 —— Texas clays and their origin.

Science, vol. xxii, pp. 297–300.

Gives chemical analyses of clays from Ohio, Kentucky, and Arkansas. Describes the character of the Tertiary deposits of Texas and discusses the question of their origin.

527 **Keyes** (Charles Rollin). Eastern extension of the Cretaceous in Iowa.

Iowa Acad. Sci., Proc., vol. i, part ii, p. 21.

Brief notes on the recent discovery of some Cretaceous fossils in a sandstone near Des Moines.

528 —— Age of certain sandstones near Iowa City [Iowa].

Iowa Acad. Sci., Proc., vol. i, part ii, p. 26 (½ p.)

Brief note on a sandstone at this locality, provisionally assigned to the Kinderhook group of the Carboniferous.

529 —— Notes on the Redrock sandstone [Iowa].

Iowa Acad, Sci., Proc., vol. i, part ii, pp. 26–27.

Describes the lithologic character of the sandstone of Carboniferous age occurring in Marion County, Iowa, and discusses the evidences indicating its former extension.

530 —— Natural gas and oil in Iowa.

Iowa Acad. Sci., Proc., vol. i, part iii, pp. 15–18.

Discusses the general manner of accumulation of oil and the evidences indicating that such conditions are fulfilled in Iowa rocks.

531 —— Iowa Mineralogical notes.

Iowa Acad. Sci., Proc., vol. i, part iii, pp. 18–22.

Describes occurrences of pyrite, calcite, gypsum, millerite and the occurrence of granite and olivine diabase in northwestern Iowa.

532 —— Surface disintegration of granitic masses.

Iowa Acad. Sci., Proc., vol. i, part iii, pp. 22–24.

Describes particularly the disintegration of same Maryland granites.

533 —— Some American eruptive granites.

Iowa Acad. Sci., Proc., vol. i, part iii, pp. 24–26.

Discusses the theories as to the origin of large granitic masses and describes the field relations, inclusions, and contact phenomena of certain Maryland granites.

534 **Keyes** (Charles Rollin). Geological formations of Iowa.

Iowa Geol. Surv., 1st Ann. Rept., 1892, vol. i, pp. 13–144.

Gives the general geologic section of Iowa. Describes the lithologic characters and relations of the Cambrian, Silurian, Devonian, and Carboniferous strata, with more detailed description of the Coal Measures, Cretaceous, and Quaternary formations. Accompanied by colored geologic map of the State and sections.

535 —— Annotated catalogue of minerals.

Iowa Geol. Surv., 1st Ann. Rept., vol. i, 1892, pp. 183–196.

Contains a list of minerals found in Iowa, with brief notes on their occurrence and mineralogic characters.

536 —— Bibliography of Iowa geology.

Iowa Geol. Surv., 1st Ann. Rept., vol. i, 1892, pp. 211–464.

Gives a list of papers treating of the geology of Iowa.

537 —— The Platyceras group of Paleozoic gasteropods.

Am. Geol., vol. x, pp. 273–277.

Mentions the difficulties which attend an attempt at separation of certain members of this group, gives a list of American platycerata assigned to each of three easily recognized groups, and describes the growth of the gasteropod shell.

538 —— The present basal line of delimitation of the Carboniferous in northeastern Missouri.

Am. Geol., vol. x, pp. 380–384.

Discusses the fossil evidences found in the Kinderhook beds, which, though hitherto assigned to the Lower Carboniferous, yield fossils of Devonian facies. Considers that there is marked unconformity between the Carboniferous and Devonian instead of the regular sequence of strata heretofore assumed.

539 —— The unconformity of the Coal Measures and the St. Louis limestone in Iowa.

Am. Geol., vol. xii, p. 99–102.

Describes briefly the lithologic character of the Carboniferous rocks and the movements of elevation and subsidence occurring during their deposition.

540 —— A new locality for millerite.

Am. Geol., vol. xi, p. 126.

Remarks on an occurrence of millerite in geodes in Keokuk limestone.

541 —— The principal Mississippi section.

Geol. Soc. Am., Bull., vol. iii, pp. 283–300.

Abstracts: Am. Geol., vol. x, p. 125 (⅛ p.); Am. Nat., vol. xxvi, p. 1027.

Gives the section at several localities. Divides the rocks into the Kinderhook, Osage, St. Louis, and Kaskaskia groups. Describes the lithologic character of the beds and their geologic structure.

542 —— Some Maryland granites and their origin.

Geol. Soc. Am., Bull., vol. iv, pp. 299–304.

Mentions localities where the granites occur, reviews the two theories of the origin of these granites, and discusses the evidence bearing on this question.

543 —— Epidote as a primary component of eruptive rocks.

Geol. Soc. Am., Bull., vol. iv, pp. 305–312.

Describes the occurrence and characteristics of epidote-bearing rocks and its mineralogic associate, allanite, and the character and abundance of epidote in Maryland granites.

544 **Keyes** (Charles Rollin). Sketch of the coal deposits of Iowa.

U. S. Geol. Surv., Min. Res., 1892, pp. 398–404.

Describes the strata in which the coal seams occur and states that they cover nearly one-third the surface of the State. The coal basins are thicker in the center and gradually become attenuated toward the margins.

545 —— An old volcanic eruption in Iowa.

Science, vol. xxi, p. 132.

Describes the occurrence of a basic rock of eruptive origin and mentions an occurrence of quartz-porphyry in the same region.

546 —— "Nickel ore" from Iowa.

Eng. and Min. Jour., vol. liv, p. 634.

Refers to the report of finding nickel ore in Iowa and mentions an occurrence in the Keokuk limestone of calcite covered with needles of millerite.

547 —— A remarkable fauna at the base of the Burlington limestone in northeastern Missouri.

Am. Jour. Sci., 3d ser., vol. xliv, pp. 447–452.

Gives a vertical section, with a statement as to the geologic age of the different beds and a list of the characteristic fossils. The fauna are predominantly molluscan, typical of the Kinderhook beds, presenting a marked instance of a lower fauna suddenly appearing in the midst of a higher, with practically no change of lithologic characters.

548 —— and **Call** (R. E.). On a Quaternary section 8 miles southeast of Des Moines, Iowa.

Iowa Acad. Sci., Proc., vol. i, part ii, p. 30 ($\frac{1}{3}$ p.).

Brief description of the section and list of fossils found in the loess.

549 **King** (Clarence). The age of the earth.

Am. Jour. Sci., 3d ser., vol. xlv, pp. 1–20.

Abstract: Jour. of Geol., vol. i, pp. 202–203.

Gives results of a physical investigation, by Barus, of diabase as bearing upon the probable density and composition of the outer crust of the earth. In Pl. I variations of earth pressures and temperatures for radius are given, showing that the latter cease to increase within one-tenth radius from the surface. Pl. II indicates the distribution of earth temperatures and melting points of diabase for the superficial 0.08 of radius. Discusses Kelvin's and Croll's estimates of earth-time and earth-age as measured by sun-age, and concludes that the earth's age of about 24 million years accords with the estimate of that of the sun of 15 to 20 million years.

550 **Kirby** (Edmund R.). The ore deposits of Creede and their possibilities.

Eng. and Min. Jour., vol. liii, pp. 325–326.

Describes the geologic formations of the region and the veins or fissures in which the valuable minerals are found.

551 **Kloos** (J. H.). Geognostic and geographic observations in the State of Minnesota.

Minn. Geol. and Nat. Hist. Surv., 19th Ann. Rept., pp. 81–121.

General description of drift deposits in the State, the Lower Silurian and Archean of the Upper Mississippi, the Cretaceous and crystalline rocks of Sauk Valley, the Lower Silurian and Huronian melaphyre of the St. Croix Valley, the Upper Huronian slates of St. Louis River and the Silurian melaphyre and gabbro of Lake Superior with a résumé of results.

552 **Knowlton** (F. H.). Notes on a few fossil plants from the Fort Union group of Montana, with a description of one new species.

U. S. Nat. Mus., Proc., vol. xvi, pp. 33–36, pls. i–ii.

Describes and figures Populus meedsii n. sp. and Pterospermites cupanioides Newby.

553 —— Bread-fruit trees in North America.

Science, vol. xxi, pp. 24–25.

Describes the geographic distribution of certain species of bread-fruit trees in western North America, existing in Miocene or Pliocene time.

554 —— Note on a supposed new endogenous tree from the Carboniferous.

Science, vol. xxi, pp. 332–333.

Reviews the description of Winchellina fascina and considers that it may belong to one of the recently differentiated genera of the genus Psaronius.

555 —— Flora of the Dakota group, by Leo Lesquereux. Edited by F. H. Knowlton.

See Lesquereux (Leo), 582.

556 —— [Letter to I. C. Russell on fossil wood from the Triassic of North Carolina and review of Triassic plants of Prince Edward Island.]

U. S. Geol. Surv., Bull. No. 85, p. 29.

Refers to certain species from Prince Edward Island heretofore referred to the Trias which the writer considers are mostly Paleozoic.

557 —— Report on interglacial earth from Iowa.

U. S. Geol. Surv., 11th Ann. Rept., part i, p. 493.

Considers the material to be largely of vegetable origin and to belong either to the genus Juniperus or Thuya.

558 —— Description of a new fossil species of Chara.

Bot. Gazette, vol. xviii, pp. 141–142.

Describes Chara stantoni n. sp. from the Bear River Cretaceous formation of Wyoming.

559 —— Annotated list of fossil plants of the Bozeman, Montana, coal field, with table of distribution and description of new species.

U. S. Geol. Surv., Bull. No. 105, pp. 43–63, pls. v–vi.

Abstracts: Am. Jour. Sci., 3d ser., vol. xliv, p. 334 (⅓ p.); Wash. Biol. Soc., Proc., vol. vii, pp. 153–154.

Mentions the localities and the collectors of the material on which the paper is based, gives a list of species and description of new species, a table showing their geologic distribution, and discusses their value in confirming the results of stratigraphy.

560 —— Report on fossil plants from near Ellenburg, Washington.

U. S. Geol. Surv., Bull. No. 108, Appendix, pp. 103–104.

Gives a list of species and a brief description of them, with a statement as to their value in determining the age of the beds in which they were found.

561 **Koenig** (George A.). Paramelaconite and footeite.

Abstract: Am. Jour. Sci., 3d ser., vol. xliii, p. 158 (⅔ p.).

562 —— and **Hubbard** (L. L.). On powellite from a new locality.

Am. Jour. Sci., 3d ser., vol. xlvi, pp. 356–358.

Describes the mineralogic character and chemical composition of material obtained from Houghton County, Mich.

563 **Krassnof** (A. N.). The "black earth" of the steppes of southern Russia.

Geol. Soc. Am., Bull., vol. iii, pp. 68–81.

Describes the influence of the climate and relative age of the ground and subsoil on the properties of "black earth" and discusses the question of its geologic age. Discussed by E. W. Hilgard and G. C. Broadhead.

564 **Kummel** (Henry B.). Some rivers of Connecticut.

Jour. of Geol., vol. i, pp. 371–393.

Describes some of the topographic features of the State, the character of the Cretaceous peneplain, and the effects of the post-Cretaceous uplift. Discusses the changes that have taken place in certain rivers since Mesozoic time.

565 **Kunz** (George F.). Mineralogical notes on brookite, octahedrite, quartz, and ruby.

Am. Jour. Sci., 3d ser., vol. xliii, pp. 329–330.

566 —— Mineralogical notes on brookite, octahedrite, and quartz.

Cal. State Min. Bur., 11th Rept., 1893, pp. 207–209.

Notes on minerals found in Eldorado County, Cal.

567 —— Precious stones.

U. S. Geol. Surv., Min. Res., 1893, pp. 680–702.

Describes sapphire deposits of Montana, the occurrence of rubies in North Carolina, of tourmaline in Maine and California, and of opal in Idaho.

568 —— and **Huntington** (Oliver W.) On the diamond in the Canyon Diablo meteoric iron and on the hardness of carborundum.

Am. Jour. Sci., 3d ser., vol. xlvi, pp. 470–473.

Gives the results of different experiments on the Canyon Diablo iron, one of them showing the material to be diamond or a similar substance. Experiments with carborundum show that it would not scratch or polish a diamond, and therefore is inferior to it in hardness.

L.

569 **Ladshaw** (George E.). Spartanburg, S. C., gold fields.

Eng. and Min. Jour., vol. liv, p. 52 (correspondence).

Describes the placer deposits occurring in this vicinity and the character of the associated gravel and clay beds.

570 **Lampard** (Henry). A few notes on an extinct volcano at Montreal, Canada.

Abstract: Am. Assoc. Adv., Proc., vol. xl, p. 260 (4 l.).

Descriptive geology and notes on minerals occurring in dikes.

571 **Langdon** (Daniel W.). Leaf impressions in the Eocene Tertiary of Alabama.

Science, vol. xxi, pp. 94–95 (correspondence).

Mentions localities in this State where there are occurrences of Tertiary fossil leaves.

572 **Lapworth** (C.). [Address as president of the Section of Geology.]

Brit. Assoc. Adv. Sci., Rept. 1892, pp. 695–707; Am. Geol., vol. x, pp. 225–242.

Discusses the phenomena of folds and faults and their influence on the form and structure of the earth's crust. Incidentally refers to the structure of the mountain ranges of America.

573 **Lawson** (Andrew C.). The Cordilleran Mesozoic revolution.

Jour. of Geol., vol. i, pp. 579–586.

Reviews the previous work in this region. Considers that the pre-Cretaceous Mesozoic revolution affected the entire extent of the Cordilleras, though it may not have been synchronous in all parts. Batholitic magmas were developed, invading and replacing large portions of the crust, and cooled as acid plutonic rocks. They were followed by continental uplift; hence the conditions commonly accepted as Archean are not peculiar to rocks of that age.

574 —— The Norian rocks of Canada.

Science, vol. xxi, pp. 281–282.

Reviews the monograph on norian rocks by Frank D. Adams, gives localities where anorthosite rocks occur, and some of the results of their study.

575 —— The anorthosites of the Minnesota shore of Lake Superior.

Minn. Geol. and Nat. Hist. Surv., Bull. No. 8, pp. 1–23.

Abstracts: Am. Geol., vol. xii, p. 59; Am. Nat., vol. xxvii, p. 898.

Refers to previous descriptions of the rocks. Describes the petrographic characters and gives chemical analyses and discusses the geologic relations of the anorthosites.

576 —— The laccolitic sills of the northwest coast of Lake Superior.

Minn. Geol. and Nat. Hist. Surv., Bull. No. 8, pp. 24–48.

Abstract: Am. Geol., vol. xii, pp. 59–60.

Reviews the literature on the rocks of this district and discusses the theories advanced as to the relations of the trap sheets. Describes the petrographic characters of diabase and quartz-porphyry and their contact relations and phenomena.

577 —— Sketch of the coastal topography of the north side of Lake Superior, with special reference to the abandoned strands of Lake Warren.

Minn. Geol. and Nat. Hist. Surv., 20th Ann. Rept., pp. 181–289.

Abstract: Am. Geol., vol. xi, pp. 356–357.

Gives a brief statement concerning the formations bordering on Lake Superior and the conditions peculiar to each. Discusses the relations of the topography to the rock structure and describes the coastal contours and profiles. Concludes that Lakes Superior, Michigan, and Huron are remnants of the greater Lake Warren and occupy its subordinate depressions.

578 **LeConte** (Joseph). Theory of the origin of mountain ranges.

Jour. of Geol., vol. i, pp. 542–573; Sci. Amer. Suppl., vol. xxxvi, pp. 14768–14769 and 14776–14778.

Describes the structure of mountain ranges and the character of the materials of which they are composed. Theories are divided into two classes, the formal theory and the causal or physical theory. Gives the formal theory in detail and discusses the contractional and the alternative physical theories, and concludes that, in spite of many objections, the former still affords the best working hypothesis among causal theories.

579 **Lenke** (H.), **Felix** (J.) and. Beitrage zur Geologie und Paleontologie der Republik Mexico.

See Felix (J.) and Lenke (H.), 316.

579*a* —— Ueber die tektonischen Verhältnisse der Republik Mexico.

See Felix (J.) and Lenke (H.), 317.

580 **Lesley** (J. P.). A summary description of the geology of Pennsylvania.

Pa. Geol. Surv., Final Report, vol. i, pp. 1–719.

Abstract: Am. Jour. Sci., 3d ser., vol. xliii, p. 536 (½ p.).

Contains a discussion of some primary geologic principles, classification, and nomenclature, and a description of the Laurentian, Huronian, Cambrian, and Lower Silurian formations of the State, which includes a description of the crystalline gneisses and schists and their typical exposures, the geology of South Mountain, the Primal slates and their iron mines, and the limestones of the Great Valley, its subdivisions and deposits of iron, lead, and zinc, and the fossils found in these limestones.

581 —— A summary description of the geology of Pennsylvania.

Pa. Geol. Surv., Final Report, vol. ii, pp. 721–1628.

Abstract: Am. Jour. Sci., 3d ser., vol. xlv, p. 73 (6 l.).

Describes the Upper Silurian and Devonian formations, including a description of the Clinton sandstones, shales, and slates, and their fossil iron-ore bodies, and the Niagara limestone and Salina shales and their fossils, as exposed in various portions of the State.

582 **Lesquereux** (Leo). The flora of the Dakota group. A posthumous work, edited by F. H. Knowlton.

U. S. Geol. Surv., Monograph XVII, 1892, pls. i–lxvi.

Abstracts: Jour. of Geol., vol. i, pp. 300–302; Am. Geol., vol. xii, pp. 328–329; Am. Nat., vol. xxvii, p. 1079 (⅜ p.).

Includes description of the species found in the Dakota group and a table showing their distribution in other formations and countries.

583 —— The Genus Winchellia.

Am. Geol., vol. xii, pp. 209–213.

Describes its characters and contains correspondence concerning the adoption of the name Winchellia.

584 **Leverett** (Frank). The glacial succession in Ohio.

Jour. of Geol., vol. i, pp. 127–146.

Abstract: Am. Geol., vol. xi, pp. 413–415.

Discusses the phenomena attending the different stages of the glacial epoch and the evidences which indicate the existence of an interval of deglaciation. Summarizes the present knowledge concerning the altitude in each stage. Accompanied by a map showing the area covered by the Maumee-Miami glacier.

585 **Leverett** (Frank). On the significance of the white clays of the Ohio region.

Am. Geol., vol. x, pp. 18–24.

Abstract: Am. Nat., vol. xxvii, p. 148.

The distribution of the clays shows that their deposition was not connected with an ice dam at or below Cincinnati. Compares them with the Upper Mississippi Valley silts, and considers that the deposition of the clays took place under conditions similar to those of the latter.

586 —— The Cincinnati ice dam.

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xl, pp. 250–251.

Concludes that the theory of an ice dam at this point is questionable, since the silt deposits are too widespread and were deposited upon and are separated from the ice drift by a considerable time interval.

587 —— On the correlation of moraines with raised beaches of Lake Erie.

Am. Jour. Sci., 3d ser., vol. xliii, pp. 281–301; Wis. Acad. Sci. Arts and Letters, Proc., vol. viii, pp. 233–240.

Abstracts: Jour. of Geol., vol. i, pp. 99–100; Am. Nat., vol. xxvi, pp. 412–414.

Discusses the evidence of the existence of lakes in the drift-covered area of Ohio toward the close of the Glacial period. Considers that in its earlier stages Lake Erie occupied but a portion of its present area, the remainder being covered by the ice sheet. The extension of the lake area followed the retreat of the ice sheet, the beaches were replaced by lateral moraines, and it is probable that similar moraines will be found to connect with the beaches of Lake Ontario.

588 —— Notes bearing upon the changes in the pre-Glacial drainage of western Illinois and eastern Iowa.

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xli, p. 176 (⅓ p.).

589 —— Relation of the attenuated drift border to the outer moraine in Ohio.

Am. Geol., vol. xi, pp. 215–216 (correspondence).

590 **Lewis** (Julia F.). H. Carvill Lewis's work on the glacial phenomena.

Science, vol. xix, pp. 305–306.

In a letter to Prof. G. F. Wright gives a summary of Professor Lewis's later views on glacial phenomena.

591 **Lincoln** (D. F.). Glaciation in the Finger Lake region of New York.

Am. Jour. Jour. Sci., 3d ser., vol. xliv, pp. 290–301.

Abstract: Am. Geol., vol. xii, pp. 177–178 (⅓ p.).

Gives a general sketch of the geology and topography of the country, illustrated by a map. Discusses the evidence concerning the pre-Glacial topography and the amount of glacial corrasion.

592 **Lindgren** (Waldemar). The gold deposit at Pine Hill, California.

Am. Jour. Sci., 3d ser., vol. xliv, pp. 92–96.

Abstract: Eng. and Min. Jour., vol. liv, p. 610.

Brief description of the occurrence of gold deposits in California and of the locality in which this deposit occurs. The gold in many places is associated with barite in irregular veins or seams in a zone of decomposed or kaolinized diabase.

593 **Lindgren** (Waldemar). Notes on the geology and petrography of Baja California, [Mexico].

Cal. Acad. Sci., Proc., 2d ser., vol. iii, part i, pp. 25–33.

Gives the results of the study of rock specimens obtained in this region and a general statement of the orographic movements that have taken place.

594 —— The relation between ore deposits and their inclosing walls.

Eng. and Min. Jour., vol. lv, pp. 340–341.

Reviews a previous article on the same subject, with statements concerning the "lateral secretion" theory and the manner of occurrence of gold in California.

595 —— Sacramento sheet.

U. S. Geol. Surv., Geol. atlas of the U. S., Preliminary edition, 1892.

Gives a general outline of the geologic history of the Gold Belt region of California. Describes the topographic features, the character of the auriferous slates, igneous rocks, and the Cretaceous, Miocene, and Pleistocene strata. Accompanied by topographic, colored areal and economic geologic, and structure-section maps.

596 —— The auriferous veins of Meadow Lake, California.

Am. Jour. Sci., 3d ser., vol. xlvi, pp. 201–206.

Describes the distribution and general character of the rocks of the district, illustrated by a sketch map, and the structure of the ore deposits and the character of the ore and gangue material.

597 —— Eruptive rocks from Montana.

Cal. Acad. Sci., Proc., 2d ser., vol. iii, part. i, pp. 39–57.

Abstract: Am. Nat., vol. xxvi, p. 698 (8 l.).

These rocks do not occur as lava flows, but as dikes, sheets, or laccolites in sedimentaries. Describes the megascopic and microscopic characters of the rocks, which include dacites, hornblende-andesites, diorites, augite-syenites, trachytes, and basalts.

598 —— A sodalite-syenite and other rocks from Montana, with analyses by W. H. Melville.

Am. Jour. Sci., 3d ser., vol. xlv, pp. 286–297.

Abstracts: Jour. of Geol., vol. i, pp. 634–638; Am. Nat., vol. xxvii, pp. 563–564; Am. Jour. Sci., 3d ser., vol. xlvi, p. 76 ($\frac{1}{6}$ p.).

Describes the geologic occurrence of the rocks from which the specimens were collected and their petrographic character, with tables showing their chemical composition.

599 —— Two Neocene rivers of California.

Geol. Soc. Am., Bull., vol. iv, pp. 257–298.

Abstracts: Am. Geol., vol. xii, p. 121 ($\frac{3}{4}$ p.); Am. Nat., vol. xxvii, p. 1084 ($\frac{1}{6}$ p.).

Reviews the literature on the Sierra Nevada region and gives a summary of its geologic history, illustrated by cross sections. Describes the course of the Neocene rivers, Yuba and American, and their gravel deposits. Concludes that the Neocene Sierra Nevada formed a distinct mountain range similar to the modern one. Includes a map of the Recent and Neocene drainage systems and the grades of the Neocene rivers.

600 **Low** (A. P.). Report on the geology and economic minerals of the southern portion of Portneuf, Quebec, and Montmorency counties, Quebec.

Can. Geol. Surv., Reports, vol. v, new series, 1890–91, part i, Report L, 71 pp.

Describes the Archean rocks, the Trenton limestone, and Utica shale, and the distribution of the Trenton, and gives lists of fossils found in it. Describes the glacial phenomena and gives a list of post-Pliocene fossils found.

601 —— Notes on the glacial geology of western Labrador and northern Quebec.

Geol. Soc. Am., Bull., vol. iv, pp. 419–421.

Describes the glacial phenomena of the region and the extent of Pleistocene changes of level in Labrador.

602 **Lucas** (F. A.). On Carcharodon mortoni Gibbes.

Wash. Biol. Soc., Proc., vol. vii, pp. 151–152.

Considers that the characters of the teeth of C. mortoni Gibbes, described by Gibbes, are due to an accident while young and that it should stand as a synonym of C. megalodon Agassiz.

603 **Ludeking** (C.). Synthesis of the minerals crocoite and phænicrocoite.

Am. Jour. Sci., 3d ser., vol. xliv, pp. 57–58.

604 **Lyman** (Benjamin Smith). The great Mesozoic fault in New Jersey.

Am. Phil. Soc., Proc., vol. xxxi, No. 142, pp. 314–317.

Describes the topographic and geologic features which indicate the existence of this fault.

605 —— An occurrence of coarse conglomerate above the mammoth anthracite bed.

Am. Inst. Min. Engrs., Trans., vol. xxi, pp. 713–719.

Presents a geologic and topographic map of a portion of Schuylkill County, Pa., where the conglomerate occurs, and discusses the geologic structure of the region and the relation between the coal beds and conglomerate.

M.

606 **McBride** (T. H.). A new cycad.

Am. Geol., vol. xii, pp. 248–250.

Describes and figures specimens from South Dakota considered to be from Lower Cretaceous or Jura-Trias rocks.

607 **McCalley** (Henry). Alabama bauxite.

Eng. and Min. Jour., vol. liv, p. 584; Science, vol. xx, p. 303.

Describes the geologic features of its occurrence and gives a chemical analysis.

608 **McCallie** (S. W.). Remains of the mastodons recently found in Tennessee.

Science, vol. xx, p. 333.

Brief description of the portions discovered.

609 **McCharles** (A.). The Algoma nickel mines [Ontario].

Eng. and. Min. Jour., vol. liv, p. 147 (correspondence).

Contains brief description of the geologic occurrence of the ore bodies in the Province of Ontario.

610 **McConnell** (R. G.). Report on a portion of the district of Athabasca, comprising the country between Peace River and Athabasca River north of Lesser Slave Lake.

Can. Geol. Surv., Reports, vol. v, new series, 1890–91, part i, Report D, 62 pp.

Describes the general physical features of the region. Gives several sections, with lists of fossils obtained, which consist of Devonian and Cretaceous types. The Cretaceous apparently overlies the Devonian conformably. The unequal distribution of glacial deposits produces a rolling type of country, and to it is due the large number of lakes and ponds which cover a considerable portion of its area. Gold was found in the bars of the rivers, and deposits of bitumen and indications of gas and oil were found.

611 **McCreath** (A. S.) and **D'Invilliers** (E. V.). The Clinch Valley coal fields.

U. S. Geol. Surv., Min. Res., 1892, pp. 521–528.

The Coal Measures belong to the Middle Coal series of Virginia and West Virginia, identical with the Lower Productive Coal series of Pennsylvania, which, in this region, carry five well-marked coal beds.

612 **McFarland** (R. W.). The close of the Ice age in North America.

Science, vol. xxii, pp. 45–46.

Reviews some of the theories on this question.

613 **McGee** (W J). The Gulf of Mexico as a measure of isostasy.

Am. Jour. Sci., 3d ser., vol. xliv, pp. 177–192.

Abstracts: Am. Geol., vol. xi, p. 58 (⅓ p.); Geol. Soc. Am., Bull., vol. iii, pp. 501–503.

Discusses the evidences of the instability of the continents and of the encroachments of the sea in the region of the Gulf of Mexico. Concludes that the modern movement is slight, while the old movements were cataclysmic; that the land and sea are here in a state of hydrostatic equilibrium, and that these observations are corroborated by data from other prominent deposition tracts of the globe.

614 —— The Pleistocene history of northeastern Iowa.

U. S. Geol. Surv., 11th Ann. Rept., part i, pp. 199–577, pls. i–lxi, figs. 1–120.

Abstracts: Am. Geol., vol. xi, pp. 178–179; Am. Jour. Sci., 3d ser., vol. xlv, p. 71.

Contains a discussion of geologic principles, a description of the geologic formations of the region, their deformation, the topographic features and glacial phenomena.

615 —— The Lafayette formation.

U. S. Geol. Surv., 12th Ann. Rept., part i, pp. 353–521.

Abstract: Am. Jour. Sci., 3d ser., vol. xlv, p. 163 (5 l.).

Describes the geologic formations of the Atlantic Coastal Plain and their economic resources and reviews the geologic history of the Lafayette formation.

616 —— Note on the "age of the earth."

Science, vol. xxi, pp. 309–310.

Discusses the different estimates of the duration of the different geologic periods and presents a table showing the mean, minimum, and maximum estimates of the various geologic ages.

617 **McGee** (W J). The field of geology and its promise for the future.

Minn. Acad. Nat. Sci., Bull., vol. iii, pp. 191–206.

Discusses the general principles of geology and presents a classification of geologic processes.

618 —— The areal work of the United States Geological Survey.

Am. Geol., vol. x, pp. 377–379.

Gives a general description of its work since the organization of the present Survey.

619 —— Rock gas and related bitumens. Introduction to "The natural gas field of Indiana," by A. J. Phinney.

U. S. Geol. Surv., 11th Ann. Rept., part i, pp. 589–616.

Describes the constitution and geologic distribution of bitumens and discusses the origin of rock gas and other bitumens.

620 —— Neocene and Pleistocene continent movements.

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xl, pp. 253–254.

Gives a brief history of continental oscillations. Concludes that there were two periods of rapid oscillations; each submergence was comparatively short and immediately followed by a maximum high level, and that the two are separated by a great time interval.

621 —— [Glacial phenomena.]

Geol. Soc. Am., Bull., vol. iv, pp. 5–6 and 6–7.

In discussion of paper by C. H. Hitchcock, "Studies of the Connecticut Valley glacier."

622 —— A fossil earthquake.

Abstract: Geol. Soc. Am., Bull., vol. iv, pp. 411–414.

Discusses the origin of certain dome structures of the Mississippi Valley.

622*a* **McInnes** (W.), **Bailey** (L. W.) and. Report on portions of the Province of Quebec and adjoining areas in New Brunswick and Maine.

See Bailey (L. W.) and McInnes (W.), 23.

623 **MacMechen** (Thomas R.). The ore deposits of Creede, Colo.

Eng. and Min. Jour., vol. liii, pp. 301–303.

Describes the geologic formations of the region and the nature and extent of the ore bodies.

624 **Marcou** (Jules). The Tucumcari fossils.

Science, vol. xxi, pp. 358–360.

Reviews the determinations of certain fossils from this region.

625 —— On the classification of the Dyas, Trias, and Jura in northwest Texas.

Am. Geol., vol. x, pp. 369–377.

Discusses the classification and nomenclature for the strata in northwest Texas used in the second and third annual reports of the Geological Survey of Texas.

626 —— Second supplement to "Mapoteca Geologica Americana," 1752–1881.

Am. Geol., vol. xi, pp. 95–99.

Gives titles of maps, date, and place of publication.

627 **Marcou** (Jules). Remarks on a part of the review of the Third Texas Report.

Am. Geol., vol. xi, pp. 212–214 (correspondence).

Reviews statements concerning the geology of the Tucumcari region.

628 —— Cerro Tucumcari.

Am. Geol., vol. xii, pp. 103–107.

Refers to statements in paper by W. F. Cummins, "Tucumcari Mountain," and gives a brief historical sketch of the early expeditions in this region.

629 **Margerie** (M. Emm. de). Sur la découverte de phénomènes de recouvrement dans les Appalaches.

Soc. Géol. de France, Bull., 3d ser., vol. xix, No. 7, pp. 426–429.

Describes the phenomena of overthrusting in the Appalachian province and compares them with similar phenomena in southern France.

630 —— [Letter to G. K. Gilbert concerning the Bibliography undertaken by the International Congress of Geologists.]

Am. Jour. Sci., 3d ser., vol. xliii, pp. 71–73; Am. Geol., vol. ix, pp. 64–67.

Gives list of members of the committee and minutes of the first meeting.

631 **Marsh** (O. C.). The skull of Torosaurus.

Am. Jour. Sci., 3d ser., vol. xliii, appendix, pp. 81–84, pls. 2.

632 —— Discovery of Cretaceous Mammalia, Part III.

Am. Jour. Sci., 3d ser., vol. xliii, appendix, pp. 249–262, pls. v–xi.

Describes briefly the characteristics of Cretaceous Mammalia and their bearing upon the determination of the relationships of Cretaceous and Tertiary deposits, followed by description of several species.

633 —— Notice of new reptiles from the Laramie formation.

Am. Jour. Sci., 3d ser., vol. xliii, appendix, pp. 449–453.

634 —— Notes on Triassic Dinosauria.

Am. Jour. Sci., 3d ser., vol. xliii, appendix, pp. 543–546.

Review: Am. Nat., vol. xxvi, pp. 410–412.

635 —— Notes on Mesozoic vertebrate fossils.

Am. Jour. Sci., 3d ser., vol. xliv, appendix, pp. 171–176, pls. ii-v.

636 —— Restoration of Claosaurus and Ceratosaurus.

Am. Jour. Sci., 3d ser., vol. xliv, appendix, pp. 343–349.

637 —— Restoration of Mastodon americanus Cuvier.

Am. Jour. Sci., 3d ser., vol. xliv, appendix, p. 350.

638 —— A new Cretaceous bird allied to Hesperornis.

Am. Jour. Sci., 3d ser., vol. xlv, appendix, pp. 81–82.

Describes remains found in Montana.

639 —— The skull and brain of Claosaurus.

Am. Jour. Sci., 3d ser., vol. xlv, appendix, pp. 83–86.

Describes the skull of Claosaurus found in Ceratops beds of Wyoming.

640 —— Restoration of Anchisaurus.

Abstract: Am. Jour. Sci., 3d ser., vol. xlv, appendix, pp. 169–170.

Describes some of the characters of the species and discusses its possible relation to the "bird tracks" of the Connecticut River sandstone.

641 **Marsh** (O. C.). Restoration of Coryphodon.

Am. Jour. Sci., 3d ser., vol. xlvi, appendix, pp. 321–326.

Reviews the literature concerning the Coryphodon and describes the restoration of one of its species.

642 —— Description of Miocene Mammalia.

Am. Jour. Sci., 3d ser., vol. xlvi, appendix, pp. 407–412, pls. vii–x.

Describes specimens from New Jersey and the Rocky Mountain region, which indicate a common horizon in the two regions.

643 —— Restoration of Mastodon americanus Cuvier.

Sci. Amer. Suppl., vol. xxxiv, p. 14085.

Gives a brief account of other restorations and of the characteristics of this species. Illustrated by sketch.

644 **Marshall** (D. T.). Pyrite incrustations of the Cretaceous formations of Middlesex County, N. J.

Science, vol. xix, p. 151.

Describes some incrustations and replacement of trunks, twigs, and bark by iron pyrites.

645 **Marshall** (William B.). Report on a deposit of marl and peat in the town of New Baltimore.

N. Y. State Mus., 45th Ann. Rept., pp. 46–52.

The marl is composed of shells of fresh-water Mollusca and carbonate of lime. The peat and muck on its surface is an accumulation of mosses and other plants.

645*a* **Marsters** (Vernon Freeman), **Kemp** (J. F.) and. The trap dikes of the Lake Champlain region.

See Kemp (J. F.) and Marsters (V. F.), 521.

646 **Matthew** (G. F.). List of the fossils found in the Cambrian rocks in and near St. John.

New Brunswick Nat. Hist. Soc., Bull. No. 10, pp. xi–xxiii.

Describes briefly the lithologic character of the Cambrian beds of St. John basin and gives their thickness as 3,550 feet. Gives a list of 157 fossils found in these beds, which shows their stratigraphic position in the series.

647 —— Protolenus. A new genus of Cambrian trilobites.

New Brunswick Nat. Hist. Soc., Bull. No. 10, pp. 34–37.

Describes Protolenus n. gen., and Protolenus elegans n. sp., and Protolenus paradoxides from the St. John group of Canada.

648 —— The climate of Acadia in the earliest times.

New Brunswick Nat. Hist. Soc., Bull. No. 11, pp. 3–18.

Describes the general climatic conditions of this region and the character of the fauna from Cambrian to Devonian time.

649 —— Notes on Cambrian faunas.

Can. Rec. Sci., vol. v, pp. 247–258.

Describes a hitherto unrecognized group of trilobites and correlates the faunas based on these four species.

650 —— Trematobolus. An articulate brachiopod of the inarticulate order.

Can. Rec. Sci., vol. v, pp. 276–279.

Abstract: Am. Geol., vol. xii, p. 396 (¼ p.).

Describes a shell from the pre-Paradoxides beds of the St. John group and discusses its different affinities.

651 **Matthew** (G. F.). Is the fauna called "Primordial" the most ancient fauna?

Can. Rec. Sci., vol. v, pp. 347–350.

Describes the metamorphosis of the Cambrian trilobites and mentions the discovery of radiolarian remains in Azoic rocks of Great Britain.

652 —— On the diffusion and sequence of the Cambrian faunas.

Can. Roy. Soc., Proc. and Trans., vol. x, sect. iv, pp. 3–16.

Describes the development of graptolites and other deep-water organisms. Reviews the opinions of other writers concerning the distribution of Cambrian faunas, and presents in tabular form the migration of their genera.

653 —— Illustrations of the fauna of the St. John group, No. VII.

Can. Roy. Soc., Proc. and Trans., vol. x, sect. iv, pp. 85–109.

Abstract: Am. Geol., vol. xii, pp. 192–193.

Describes the fauna of the Arenig horizon in the Bretonian division; also some graptolites and brachiopods of the same division.

654 —— Illustrations of the fauna of the St. John group, No. VIII.

Can. Roy. Soc., Proc. and Trans., vol. xi, sect. iv, pp. 85–129.

Describes species chiefly from the St. John group and gives a list of Cambrian and Ordovician fossils found near St. John.

655 —— The St. John group.

Am. Geol., vol. xii, pp. 340–341 (correspondence).

656 **Matthew** (W. D.). On phosphate nodules from the Cambrian of southern New Brunswick.

N. Y. Acad. Sci., Trans., vol. xii, pp. 108–120.

Gives the subdivisions and lithologic characters of the St. John group and describes the megascopic and microscopic characters of the nodules. Compares them with other phosphate deposits and discusses the question of their origin.

657 —— On antennæ and other appendages of Triarthrus beckii.

Am. Jour. Sci., 3d ser., vol. xlvi, pp. 121–125; N. Y. Acad. Sci., Trans., vol. xii, pp. 237–241.

Abstract: Am. Geol., vol. xii, pp. 193–194 ($\frac{1}{3}$ p.).

Refers to the study of the trilobites by C. D. Walcott, with special reference to the organs of the under side, and gives a summary of the structure thus determined. Describes trilobites found in the Hudson River shales in New York and the structure of the antennæ preserved in the specimens.

658 **Meeds** (A. D.). The Stillwater deep well.

Minn. Acad. Nat. Sci., Bull., vol. iii, pp. 274–277.

Gives brief description of the rocks penetrated by the well, the section shown by the well record, and the microscopic characters of a diabase porphyrite occurring at a depth of 3,300 feet.

659 **Memminger** (C. G.). [Phosphate deposits of Tennessee.]

U. S. Geol. Surv., Min. Res., 1893, pp. 709–711.

Gives the section of the Tennessee phosphate beds and chemical analyses of samples. Describes its physical characteristics.

660 **Merrill** (George Perkins). On some basic eruptive rocks in the vicinity of Lewiston and Auburn, Androscoggin County, Me.

Am. Geol., vol. x, pp. 49–55.

Describes the rock formations of the region and the basic dikes which cut them. Shows the location and direction of the dikes on a sketch map. Describes the microscopic characters of the dike rocks, diabase, and lamprophyrs, and gives several chemical analyses.

661 —— The wind as a factor in geology.

Eng. Mag., vol. ii, pp. 596–607.

Describes some results of the action of wind in cutting away and transporting the material of the earth's crust.

662 —— Notes on the petrography of the Paleozoic section in the vicinity of Three Forks, Montana.

U. S. Geol. Surv., Bull: No. 110, pp. 47–54.

Describes the petrographic characters of gneissic rocks of the region and certain fragmental rocks which appear to have been derived from them, and the character of some intrusive rocks occurring in the lower part of the Flathead shales.

663 —— The newer eruptive rocks.

Boston Soc. Nat. Hist., Occasional Papers IV, vol. i, part i, pp. 31–44.

Describes the eruptive rocks occurring in the form of lava flows and dikes. The lava flows include melaphyrs and porphyrites. The dikes consist chiefly of diabases.

664 —— and **Packard** (R. L.). On an azure-blue pyroxenic rock from the Middle Gila, New Mexico.

Am. Jour. Sci., 3d ser., vol. xliii, pp. 279–280.

Gives a mineralogic and chemical description of the rock, occurring in serpentinous limestones, which has the formula of malacolite.

665 **Meyer** (Abraham). Notes on the occurrence of quartz and other minerals in the Chemung measures near the line of Lycoming and Tioga counties, Pennsylvania.

Phila. Acad. Nat. Sci., Proc., 1893, part i, pp. 194–196.

Describes some quartz crystals and gives the names of the associated minerals.

666 —— Pyrophyllite slates in northern Pennsylvania.

Phila. Acad. Nat. Sci., Proc., 1893, part i, pp. 197–200.

Describes some exposures of the Chemung beds of Pennsylvania.

667 **Mickle** (George). Notes on nickel.

Can. Inst., Trans., vol. ii, part i, pp. 77–92.

Contains notes on the occurrence of nickel, its mineral associates, and its metallurgy.

668 **Miers** (H. A). Quartz from the Emerald and Hiddenite mines.

Am. Jour. Sci., 3d ser., vol. xlvi, pp. 420-424.

Describes the crystallographic characters of quartz crystals from North Carolina.

669 **Miller** (S. A.). The structure, classification, and arrangement of American Paleozoic crinoids into families.

Ind. Dept. Geol. and Nat. Hist., 16th Rept., 1888, pp. 302–326.

Reviews the opinions of several writers on the structure and classification of crinoids and describes some of their important family characteristics.

670 **Miller** (S. A.). Paleontology.

Ind. Dept. Geol. and Nat. Hist., 17th Rept., 1891, pp. 611–705, pls. i–xx.

Describes species found in Silurian, Devonian, and Carboniferous series of Indiana and Missouri.

671 —— and **Faber** (C.). Description of some sub-Carboniferous and Carboniferous Cephalopoda.

Cin. Soc. Nat. Hist., Jour., vol. xiv, pp. 164–168.

Describes species from Coal Measures in Kentucky and near Kansas City, Mo.

672 —— Some new species and new structural parts of fossils.

Cin. Soc. Nat. Hist., Jour., vol. xv, pp. 79–87.

Abstract: Am. Geol., vol. x, pp. 316–317.

Describes specimens obtained from the Hudson River group from near Cincinnati.

673 **Miller** (S. A.) and **Gurley** (F. E.). Description of some new genera and species of Echinodermata from the Coal Measures and sub-Carboniferous rocks of Indiana, Missouri, and Iowa.

Ind. Dept. Geol. and Nat. Hist., 16th Rept., 1888, pp. 327–373.

Contains description of new genera and species of Echinodermata from the Carboniferous of the States mentioned.

674 **Mills** (James E.). Stratigraphy and succession of the rocks of the Sierra Nevada of California.

Geol. Soc. Am., Bull., vol. iii, pp. 413–444.

Abstracts: Am. Geol., vol. x, pp. 318–319; Am. Nat., vol. xxvii, p. 147 (¼ p.).

Repeated uplifts along the same axes, followed by erosion, mark the orographic history of this range, and the present relief is due to Tertiary and Quaternary uplifting. Granites form the core and the great mass of the range and constitute the principal part of the pre-Mesozoic rocks. The Mesozoic sediments are mainly slates and some limestones. The eruptives consist of medium basic lavas altered to diabases or greenstones, and very basic lavas altered to serpentines.

675 **Mitchell** (R. H.) and **Baskerville** (C.). An example of river adjustment.

Elisha Mitchell Sci. Soc., Jour., part ii, 1892, pp. 64–66.

Describes and illustrates the processes of adjustment that have occurred in certain tributaries of the James River in Virginia.

676 **Moore** (Joseph). The recently found Casteroides in Randolph County, Indiana.

Am. Geol., vol. xii, pp. 67–74.

Describes the locality where the remains were found, gives a list of parts found and those missing and broken, some measurements, and a list of fragments from the same and other localities.

677 —— An inquiry as to the cause of variety in rock deposits as seen in Hudson River beds at Richmond, Indiana.

Ind. Acad. Sci., Proc., 1892, pp. 26–27.

Describes briefly some of the deposits in this vicinity.

678 **Moore** (Joseph). Glacial and pre-Glacial erosion in vicinity of Richmond, Indiana.

Ind. Acad. Sci., Proc., 1892, pp. 27–29.

Mentions a buried river channel and the discovery of potholes in this locality.

679 **Moses** (Alfred J.). One of the gypsum crystals from the cave at South Wash, Wayne County, Utah.

Science, vol. xxi, pp. 230–231.

Gives the crystallographic measurements of the crystal.

680 —— Mineralogical notes.

Am. Jour. Sci., 3d ser., vol. xlv, pp. 488–492.

Describes the mineralogic characteristics of pyrite crystals and ettringite, including chemical analyses of the latter.

681 **Moxham** (Edgar C.). The "Great Gossan lead" of Virginia.

Am. Inst. Min. Engrs., Trans., vol. xxi, pp. 133–138.

Describes the extent and character of an ore body in southwest Virginia which carries copper and iron, with special reference to the iron contents.

682 **Mudge** (E. H.). Observations along the valley of Grand River, Michigan.

Am. Geol., vol. xii, pp. 284–288.

Describes the glacial phenomena of this region.

N.

683 **Nason** (Frank L.) The Magnesian series of the Ozark uplift.

Am. Geol., vol. xi, pp. 91–94.

Refers to the previous classification of the Magnesian series and gives results of observations in the Ozark region. Concludes that there is but one continuous bed of sandstone in this area, and proposes for it the name of Roubidoux and for the underlying heavy-bedded limestone the name Gasconade.

684 —— Notes on some of the iron-bearing rock of the Adirondack Mountains.

Am. Geol., vol. xii, pp. 25–31.

Describes minerals associated with the magnetite ores of New York and New Jersey, and gives a brief description of several ore bodies in this region.

685 —— "The correct succession of the Ozark series;" a review reviewed.

Am. Geol., vol. xii, pp. 141–147.

Reviews statements in paper by G. C. Broadhead, "The correct succession of the Ozark series," with special reference to the separation and classification of the sandstone and magnesian limestone of the Ozark region.

686 —— A report on the iron ores of Missouri.

Mo. Geol. Surv., vol. ii, 1892, pp. 1–365, pls. i–viii, figs. 1–62.

Gives a general description of iron ores and their relative values. Describes the specular ores of the porphyry region and those of the Iron Mountain and Pilot Knob districts, the red hematites of the State, the geology of the Ozark uplift, the specular ore of the sandstone district and the limonite ores. Appendix A is a description of the iron deposits of northeastern Arkansas. Appendix B contains a historical and statistical sketch of the iron industry.

687 **Nelson** (N. P.). The formation of a terrace.

Am. Geol., vol. xii, pp. 125–126 (correspondence).

Describes the topographic features of a beach ridge in Ottertail County, Minn.

688 **Nitze** (H. B. C.) Notes on some of the magnetites of southwestern Virginia and the contiguous territory of North Carolina.

Am. Inst. Min. Engrs., Trans., vol. xx, pp. 174–188.

Describes magnetite deposits of Franklin and Henry counties, Va., and of Stokes County, N. C. Includes a description of the ore bodies in the different sections and analyses of some of the ores. Discussed by Edmund Pechin, pp. 185–188.

689 —— The magnetic iron ores of Ashe County, N. C.

Am. Inst. Min. Engrs., Trans., vol. xxi, pp. 260–280.

Describes various ore bodies of the region, with chemical analyses, their location being shown on an accompanying map.

690 —— Magnetic iron ore in Granville County, N. C.

Eng. and Min. Jour., vol. liii, p. 447.

Describes the rocks with which the ore is associated and gives a chemical analysis of the ore.

691 —— Iron ores of North Carolina. A preliminary report.

N. C. Geol. Surv., Bull. No. 1, pp. 21–239, pls. i–xx, figs. 1–58, and map of the State showing the distribution of the iron ore deposits.

Describes the different varieties of iron ores, the bog ores of the eastern counties, the magnetite, specular and brown hematite ores of the eastern, central, and western crystalline areas, the titaniferous magnetites, the iron ores of the Blue Ridge and its eastern foothills and the chromic iron ores of the chrysolite rocks. Gives chemical analyses of iron ores from many counties of the State.

O.

692 **Orton** (Edward). First Annual Report of the Geological Survey of Ohio, 1890, Third Organization, pp. 1–323.

Chapter I contains the geological scale of Ohio and a sketch of its geologic structure. Other chapters comprise a discussion of the origin and accumulation of petroleum and natural gas in the Trenton and Clinton limestones and other sources of oil and gas.

693 —— Origin of the rock pressure of natural gas in the Trenton limestone of Ohio and Indiana.

Smithsonian Inst., Ann. Rept., 1891, pp. 155–162.

Discusses the causes of rock pressure, the evidence supporting the hydrostatic theory, and the general laws of gas production.

694 —— On the occurrence of a quartz bowlder in the Sharon coal of northeastern Ohio.

Am. Jour. Sci., 3d ser., vol. xliv, pp. 62–63.

Comparison of bowlders found with those found in England and description of the strata in which they occur in Ohio.

695 —— Report on the occurrence of petroleum, natural gas, and asphalt rock in western Kentucky.

Abstracts: Am. Geol., vol. ix, pp. 262–263 (⅓ p.); Am. Jour. Sci., 3d ser., vol. xliv, p. 78 (¼ p.).

Noticed in Record for 1891.

696 **Osann** (A.). Ueber ein Mineral der Nosean-Hauyn-Gruppe im Eläolith-syenit von Montreal.

Neues Jahrb. f. Min., etc., Band i, Heft 1, 1892, pp. 222–224 (correspondence).

Describes the geologic occurrence of the rock and its megascopic, microscopic, and chemical characters.

697 —— Melilite-nepheline basalt and nepheline basanite from southern Texas.

Jour. of Geol., vol. i, pp. 341–346.

Describes the petrographic characters of specimens from this region.

698 —— Report on the rocks of Trans-Pecos, Texas.

Texas Geol. Surv., 4th Ann. Rept., pp. 123–138.

Describes the petrographic characters of the igneous rocks of this region, which include granites from the Quitman Mountain, olivine diabase from the Diablo Mountains, elæolite and nepheline bearing rocks from the Davis Mountains, and a series of highly altered diabase rocks, showing ophitic structure, from the Carrizo Mountains.

699 **Osborn** (Henry Fairchild). Fossil mammals of the Upper Cretaceous beds.

Am. Mus. Nat. Hist., Bull., vol. v, pp. 311–330.

Describes the characters of the teeth of certain Cretaceous mammals and discusses their relationship to the older Jurassic and more recent Eocene types. Concludes that the Laramie fauna is distinctly separated from the Jura and more nearly related to the basal Eocene forms and that the number of distinct types is limited.

700 —— Ceratherium Tridactylum from the Lower Miocene of Dakota.

Am. Mus. Nat. Hist., Bull., vol. v, pp. 85–86.

Describes the remains from the Miocene of South Dakota.

701 —— The rise of the Mammalia in North America.

Am. Jour. Sci., 3d ser., vol. xlvi, pp. 379–392 and 448–466.

Gives a general historical sketch of the previous study of Mammalia, discusses the general principles on which their classification is based, and exhibits in tabular form the succession of North American Mammalia and their geologic distribution.

702 —— The Ancylopodia, Chalicotherium, and Artionyx.

Am. Nat., vol. xxvii, pp. 118–133.

Describes and compares some of their leading characters and discusses their relations and proper classification.

703 —— Recent researches upon the succession of the teeth in mammals.

Am. Nat., vol. xxvii, pp. 493–508.

Describes the researches bearing upon this question and gives a general summary of the work done and the conclusions that are to be drawn from it.

704 —— A reply to Professor Marsh's "Note on Mesozoic Mammalia."

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xl, p. 290 (½ p.).

Discusses the structure of a number of Mesozoic mammals.

705 —— The ancestry of Chalicotherium.

Science, vol. xix, p. 276.

Refers to some recent discoveries of this species and considers that they were derived from the Meniscotherudæ.

706 **Osborn** (Henry Fairchild). Sur la découverte du Palæonictis en Amérique.

Soc. Geol. de France, Bull., 3d ser., vol. xx, No. 7, pp. 434–436.

Describes the character of Palæonictis found in the Wasatch beds of the Rocky Mountains.

707 —— and **Wortman** (J. L.). Fossil mammals of the Wasatch and Wind River beds.

Am. Mus. Nat. Hist., Bull., vol. iv, pp. 81–147.

Abstract: Am. Jour. Sci., 3d ser., vol. xlv, pp. 159–160.

Includes the following special articles: homologies and nomenclature of the mammalian molar cusps; the classification of the Perissodactyla; the ancestry of the Felidæ; taxonomy and morphology of the primates, creodonts, and ungulates, 1 Wasatch, 2 Wind River; geological and geographical sketch of the Big Horn basin; and narrative of the expedition of 1891.

708 —— Characters of Protoceras (Marsh), the new Artiodactyl from the Lower Miocene.

Am. Mus. Nat. Hist., Bull., vol. iv, pp. 351–371.

Abstracts: Am. Jour. Sci., 3d ser., vol. xlv, p. 160 (½ p.); Am. Nat., vol. xxvii, pp. 147–148.

Description of species and discussion of characters of species recently found.

709 —— Artionyx, a new genus of Ancylopoda.

Am. Mus. Nat. Hist., Bull., vol. v, pp. 1–18.

Describes remains found in the Miocene of South Dakota.

P.

710 **Packard** (R. L.). Genesis of nickel ores.

U. S. Geol. Surv., Min. Res., 1893, pp. 170–177.

Describes the occurrence of nickel in different deposits and reviews some of the theories as to their origin.

711 —— Natural sodium salts.

U. S. Geol. Surv., Min. Res., 1893, pp. 728–738.

Describes the lakes of Utah, Nevada, and California in which sodium salts have become concentrated and gives in tabular form the composition of the salts and discusses their origin.

711*a* —— **Merrill** (G. P.) and. On an azure-blue pyroxenic rock from the Middle Gila, New Mexico.

See Merrill (G. P.) and Packard (R. L), 664.

712 **Page** (William H.). The Carboniferous age and the origin of coal.

Eng. and Min. Jour., vol. lvi, pp. 347–349.

Reviews the generally accepted theory of the character of the Carboniferous period and the origin of its coal beds, and discusses evidences which conflict with this theory.

713 **Panton** (J. Hoyes). The mastodon and mammoth in Ontario, Canada.

Brit. Assoc. Adv. Sci., Report 1891, pp. 654–655.

Gives measurements of certain portions of the remains discovered in this Province.

714 **Parker** (Richard A.). The iron ore region of Lake Superior.

Eng. Mag., vol. ii, pp. 152–175 and 285–303.

Describes the iron deposits of the Marquette, Menominee, Gogebic, Vermillion, and Mesabi ranges.

715 **Pavlow** (Alexis). On the marine beds closing the Jurassic and opening the Cretaceous, with the history of their fauna.

Geol. Soc. Am., Bull., vol. iii, pp. 61–64.

Describes the changes which took place in the development of belemnites and ammonites and the geologic epochs which they indicate.

716 **Peale** (Albert Charles). The Paleozoic section in the vicinity of Three Forks, Montana.

U. S. Geol. Surv., Bull. No. 110, pp. 9–45, pls. i–vi.

Describes the geologic structure of the region and the lithologic character and distribution of the Algonkian, Cambrian, Devonian, Carboniferous and eruptive rocks, illustrated by a colored geologic map of the region and vertical sections showing the character and thickness of the different subdivisions of the formations.

716*a* **Pearce** (Richard). [Origin of ore deposits.]

Colo. Sci. Soc., Proc., vol. iv, pp. 348–350.

In discussion of paper by P. H. van Diest on the "Evidence bearing on the formation of ore deposits by lateral secretion."

716*b* —— The eruptive dykes near Manchester, Mass.

Colo. Sci. Soc., Proc., vol. iv, pp. 365–366.

Describes an extremely basic dike rock cutting the granite in this locality.

716*c* **Pearce** (Stanley H.), **Penfield** (S. L.) and. On polybasite and tennantite from the Mollie Gibson mine, in Aspen, Colo.

See Penfield (S. L.) and Pearce (S. H.), 724.

717 **Pechin** (Edmund C.). Virginia Oriskany iron ores.

Eng. and Min. Jour., vol. liv, p. 150.

Includes description of the mining operations and the character and extent of the ore bodies.

718 —— [Magnetite ore samples in Rocky Mount section, Virginia, and their chemical analyses.]

Am. Inst. Min. Engrs., Trans., vol. xx, pp. 185–188.

In discussion of paper by H. B. C. Nitze, "Notes on some of the magnetites of southwestern Virginia and the contiguous territory of North Carolina."

719 **Penfield** (S. L.). Contributions to mineralogy by F. A. Genth. With crytallographic notes.

Am. Jour. Sci., 3d ser., vol. xliii, pp. 184–189.

Crystallographic notes on hubnerite, bismutite, and natrolite.

720 —— Contributions to mineralogy, No. 54, by F. A. Genth. With crystallographic notes.

Am. Jour. Sci., 3d ser., vol. xliv, pp. 381–389.

Describes aguilarite, metacinnabarite lollingite, rutile, quartz, danalite, yttrium-calcium fluoride, lepidolite, and fuchite.

721 **Penfield** (S. L.). On cookeite from Paris and Hebron, Me.

Am. Jour. Sci., 3d ser., vol. xlv, pp. 393–396.

Abstract: Am. Nat., vol. xxvii, pp. 901–902 (½ p.).

Describes the mineralogic characters and gives the chemical composition of specimens from these two localities.

722 —— Mineralogical notes.

Am. Jour. Sci., 3d ser., vol. xlv, pp. 396–399.

Describes the mineralogic characters and chemical composition of zunyite and the mineralogic character of xenotime, from Colorado.

723 —— On pentlandite from Sudbury, Ontario, Canada, with remarks upon three supposed new species from the same region.

Am. Jour. Sci., 3d ser., vol. xlv, pp. 493–497.

Abstract: Am. Nat., vol. xxvii, p. 902 (½ p.).

Describes the mineralogic characters of pentlandite and of the supposed new sulphides of iron and nickel, folgerite, blueite, and whartonite, all from the Sudbury district.

724 —— and **Pearce** (S. H.). On polybasite and tennantite from the Mollie Gibson mine in Aspen, Colo.

Am. Jour. Sci., 3d ser., vol. xliv, pp. 15–18.

Abstract: Am. Nat., vol. xxvii, p. 43 (⅛ p.).

724*a* —— **Wells** (H. L.) and. On herderite from Hebron, Me.

See Wells (H. L.) and Penfield (S. L.), 1018.

725 **Penhallow** (D. P.). A preliminary examination of so-called cannel coal from the Kootenai of British Columbia.

Am. Geol., vol. x, pp. 331–339.

The specimens were made up of rod-like bodies which, in their interior, show tubular and branching openings strongly suggestive of vegetable growth.

726 —— A new species of Larix from the interglacial of Manitoba.

Am. Geol., vol. ix, pp. 368–371.

Locates and describes two specimens of Larix.

726*a* —— **Dawson** (J. W.) and. Parka decipiens.

See Dawson (J. W.) and Penhallow (D. P.), 242.

727 **Penrose** (R. A. F., jr.). A Pleistocene manganese deposit near Golconda, Nevada.

Jour. of Geol., vol. i, pp. 275–282.

Discusses the character of the ore and of the beds in which it occurs and the relations of the ore body to the country rock. Considers that the manganese was locally precipitated from spring waters.

728 —— The chemical relation of iron and manganese in sedimentary rocks.

Jour. of Geol., vol. i, pp. 356–370.

Describes the geologic occurrence of iron and manganese, the processes of their transportation and deposition, and the methods by which they are precipitated from surface waters, and discusses the causes of the association and separation of iron and manganese.

729 **Penrose** (R. A. F., jr.). The Tertiary iron ores of Arkansas and Texas.

Geol. Soc. Am., Bull., vol. iii, pp. 44–50.

The ores are limonites or allied forms, occupy a belt 300 miles long and 1 to 50 wide, and are found in Eocene beds as nodular or laminated ores. The deposition was originally contemporaneous with that of the associated strata, and the ores have been subsequently segregated. Discusses the origin of the ores.

730 —— The iron deposits of Arkansas.

Ark. Geol. Surv., Ann. Rept., 1892, vol. i, pp. 1–153.

Abstract: Am. Geol., vol. x, pp. 324–325.

Gives a historical sketch of iron mining and its geologic investigations in Arkansas. Describes the general distribution of the iron deposits of the State, their geologic relations and their character and commercial value. Describes the ore bodies in the different localities of the several counties and discusses their geologic relations and origin.

731 —— Manganese, its uses, ores, and deposits.

Ark. Geol. Surv., Rept. for 1890, vol. i, pp. 642.

Abstracts: Can. Rec. Sci., vol. v, pp. 65–68; North of Eng. Inst. Min. and Mech. Engrs., Trans., vol. xlii, pp. 427–428 (½ p.).

Noticed in Record for 1891.

732 **Perrine** (Charles D.). Earthquakes in California in 1892.

U. S. Geol. Surv., Bull. No. 112, pp. 7–57, figs. 1–5.

Describes the instruments and methods employed in the work, gives a list of stations and a chronologic record of earthquakes occurring in California in 1892.

733 —— Earthquakes in California in 1893.

U. S. Geol. Surv., Bull. No. 114, pp. 9–23.

Includes a description of instruments and methods used, list of stations, and record of observations of earthquakes in California during 1893.

734 **Perry** (Stuart H.). A classification of topographic forms.

Am. Geol., vol. xii, pp. 153–159.

Discusses the general features of constructive and destructive forces in their relation to topographic forms and gives in tabular form the classification proposed.

735 **Phelps** (Frank B.). The copper region of Michigan.

Eng. Mag., vol. iv, pp. 47–63.

Abstract: North of Eng. Inst. Min. and Mech. Engrs., Trans., vol. xlii, p. 423 (⅓ p.).

Gives a brief sketch of the geology of the region and an account of the mining operations.

736 **Phillips** (William B.). A preliminary report on a part of the lower gold belt of Alabama, in the counties of Chilton, Coosa, and Tallapoosa.

Ala. Geol. Surv., Bull. No. 3, pp. 13–97.

Includes a general description of the Alabama gold fields, a history of some of the mining operations in the counties named, and an account of the character, value, and extent of the gold ores.

737 **Phillips** (William B.). Murphree's Valley and its minerals.

Eng. and Min. Jour., vol. lvi, pp. 448–449.

Gives a brief description of the geology of the region and two cross-sections.

738 —— A list of minerals containing at least 1 per cent of phosphoric acid.

Am. Inst. Min. Engrs., Trans., vol. xxi, pp. 188–196.

Discusses the effect of phosphorus on iron and steel and gives a list of minerals containing phosphoric acid, showing their composition, the per cent of phosphoric acid, and the system under which the mineral crystallizes.

739 **Phinney** (Arthur John). The natural gas field of Indiana.

U. S. Geol. Surv., 11th Ann. Rept., part i, pp. 589–742.

Describes the character and structure of the formations and the extent of the gas field and gives an account of the well borings in the various counties.

740 **Pirsson** (L. V.). Datolite from Loughboro, Ontario.

Am. Jour. Sci., 3d ser., vol. xlv, pp. 100–102.

Abstract: Am. Nat., vol. xxvii, pp. 1091–1092 (⅓ p.).

Describes the crystallographic characters of crystals from the Lacy mine in Ontario.

741 —— On the geology and petrography of Conanicut Island, Rhode Island.

Am. Jour. Sci., 3d ser., vol. xlvi, pp. 363–378.

Describes the Carboniferous conglomerates, sandstones, and shales, and the dikes which cut them. Describes the petrographic characters of the granite, minette, and phyllite, and the character of the contact metamorphic rocks.

742 **Plummer** (Fred G.). A diagonal moraine.

Am. Geol., vol. xii, pp. 231–232.

Describes a diagonal moraine occurring on Mount St. Helena, Washington.

743 **Powell** (J. W.). Report of the Director of the United States Geological Survey.

U. S. Geol. Surv., 11th Ann. Rept., part i, pp. 1–30.

Includes an account of the progress of geologic, paleontologic, and related work undertaken by the Survey during the year 1889–99.

744 —— Report of the Director of the United States Geological Survey.

U. S. Geol. Surv., 12th Ann. Rept., part i, pp. 1–19.

Gives an account of the progress of Survey work during the year 1890–91.

745 —— Report of the Director of the United States Geological Survey.

U. S. Geol. Surv., 13th Ann. Rept., pp. 3–240.

Contains a summary of the work of the Survey during the fiscal year 1891–92 and includes reports of the heads of different divisions.

746 **Powell** (S. L.). Notes on minerals recently obtained from the quarries of Jones Falls. [Maryland.]

Johns Hopkins Univ. Circ., vol. xii, No. 103, pp. 49–50.

Describes the mineralogic characters of calcite, beaumontite, and three varieties of feldspar occurring in a pegmatite vein in a quarry near Baltimore.

747 **Pratt** (N. A.). Florida phosphates: the origin of the bowlder phosphates of the Withlacoochee River district.

Eng. and Min. Jour., vol. liii, p. 380.

Describes the phosphate beds of this district and discusses the question of their origin.

748 **Preston** (E. B.). Amador County [California].

Cal. State Min. Bur., 11th Rept., pp. 139–146.

Includes notes on some of the mines of the county.

749 —— Butte County [California].

Cal. State Min. Bur., 11th Rept., pp. 150–165.

Contains notes on the mining operations and on the character of the ore in this county.

750 —— Calaveras County [California].

Cal. State Min. Bur., 11th Rept., pp. 167–178.

Contains notes on the occurrence of copper in the metamorphic slates west of the Gold Belt and on the gold mines.

751 —— Eldorado County [California].

Cal. State Min. Bur., 11th Rept., pp. 200–207.

Notes on the mineral deposits of the county.

752 —— North Fork mining district of Fresno County [California].

Cal. State Min. Bur., 11th Rept., pp. 218–223.

Describes the topography of the region, with notes on some of the mines.

753 —— Lassen County [California].

Cal. State Min. Bur., 11th Report, pp. 241–242.

Notes on the Hayden Hill mining district, with sketch map of the district.

754 —— Monterey County [California].

Cal. State Min. Bur., 11th Rept., pp. 259–262.

Notes on some gold mines.

755 —— Plumas County [California].

Cal. State Min. Bur., 11th Rept., pp. 323–333.

Notes on some of the gold mines.

756 —— San Benito County [California].

Cal. State Min. Bur., 11th Rept., pp. 370–373.

Describes briefly the geology of a portion of the Gabilan and Mount Diablo ranges.

757 —— Salton Lake [California].

Cal. State Min. Bur., 11th Rept., pp. 387–393.

Describes the depression occupied by the lake and gives a chemical analysis of the salt from the salt marsh.

758 —— Sierra County [California].

Cal. State Min. Bur., 11th Rept., pp. 400–412.

Gives the altitude of some of the peaks in this county and notes on some of the gold mines.

759 —— Tuolumne County [California].

Cal. State Min. Bur., 11th Rept., pp. 493–513.

Describes briefly the geology of the county, with remarks on the occurrence of copper on the west side of the Mother Lode and notes on the gold mines.

759*a* **Procter** (John R.). Progress of the Kentucky Geological Survey.
Abstract: Am. Jour. Sci., 3d ser., vol. xliv, p. 78 (¼ p.).

760 **Prosser** (Charles S.). The geological age of the rocks of the novaculite area [Arkansas].
Ark. Geol. Surv., Ann. Rept., 1890, vol. iii, pp. 418–423.
Reviews the literature on the age of these rocks.

761 —— Notes on Lower Carboniferous plants from the Ouachita uplift.
Ark. Geol. Surv., Ann. Rept., 1890, vol. iii, pp. 423–424.
Brief description of localities and of the lithologic characters of the strata in which the plant remains were found.

762 —— The Devonian section of central New York along the Unadilla River.
N. Y. State Mus., 46th Ann. Rept., pp. 256–288.
Describes the lithologic character of the section and gives a list of fossils collected from different localities in this region.

763 —— The thickness of the Devonian and Silurian rocks of western New York, approximately along the line of the Genesee River.
Roch. Acad. Sci., Proc., vol. ii, pp. 49–104.
Abstract: Am. Geol., vol. x, p. 257 (⅛ p.).
Reviews previous publications regarding the geologic section in this part of the State. Gives sections displayed by different well borings, and concludes that 1,250 to 1,500 feet is a conservative estimate of the thickness at Rochester. Illustrated by map of the region showing location of wells.

764 —— The thickness of the Devonian and Silurian rocks of central New York.
Geol. Soc. Am., Bull., vol. iv, pp. 91–118.
Abstract: Am. Geol., vol. xi, pp. 411–412 (⅛ p.).
Gives the section shown by several deep wells from which is deduced a general geologic section of central New York.

765 —— The Devonian system of eastern Pennsylvania.
Am. Jour. Sci., 3d ser., vol. xliv, pp. 210–221.
Discusses the fossil evidence as to the age of certain deposits in this region and of their correlation with the Tully and Genesee formations in New York. Illustrated by cross-section.

766 —— The Upper Hamilton and Portage stages of central and eastern New York.
Am. Jour. Sci., 3d ser., vol. xlvi, pp. 212–230.
Gives a historical sketch of the use of the term "Oneonta group" and list of fossils found at various localities and statements concerning their stratigraphic position, from which the author concludes that the Oneonta sandstone is not the top of the Hamilton series, but belongs to the Portage.

767 **Pumpelly** (Raphael). An apparent time-break between the Eocene and Chattahoochee Miocene in southwestern Georgia.
Am. Jour. Sci., 3d ser., vol. xlvi, pp. 445–447.
Describes the topographic features of the region and gives a list of fossils found in the Eocene and Chipola Miocene. Explains briefly the evidence indicating the existence of the time-break.

768 **Pumpelly** (Raphael) and **Van Hise** (C. R.). Observations upon the structural relations of the Upper Huronian, Lower Huronian, and Basement Complex on the north shore of Lake Huron.

Am. Jour. Sci., 3d ser., vol. xliii, pp. 224–232.

Discusses the relations of the formations at various points in the region and concludes that the pre-Keweenawan rocks on the north shore of Lake Huron are separable by unconformities into three series similar to those on the south shore of Lake Superior and Steep Rock Lake, and that the unconformities are alike in the three districts and the formations once extended over the entire area.

R.

769 **Rand** (Theodore D.). Geology of the Isles of Shoals.

Phila. Acad. Nat. Sci., Proc., 1892, part iii, pp. 324–325.

Describes the gneissoid rocks of which the islands are formed and the trap dikes which cut them.

770 —— The supposed South Chester Valley Hill fault.

Phila. Acad. Nat. Sci., Proc., 1892, part iii, pp. 445–447.

Quotes descriptions of the region from the Final Report of the Second Geological Survey of Pennsylvania and discusses some of the statements quoted.

771 —— **Jefferis** (W. W.), and **Cardeza** (J. T. M.). Mineral localities of Philadelphia and vicinity.

Phila. Acad. Nat. Sci., Proc., 1892, part ii, pp. 174–202.

Describes many rock exposures in the region and mentions the minerals found in them.

772 **Raymond** (R. W.). [Occurrence of titaniferous iron ore.]

Am. Inst. Min. Engrs., Trans., vol. xxi, pp. 274–277.

In discussion of paper by H. B. C. Nitze, "The magnetic iron ores of Ashe County, N. C."

773 —— [Vein structure.]

Am. Inst. Min. Engrs., Trans., vol. xxi, pp. 872–873.

In discussion of paper by Ernest Wiltsee, "Notes on the geology of the Half-Moon Mine, Pioche, Nev."

774 **Reade** (T. Mallard). Physics of mountain building: some fundamental conceptions.

Am. Geol., vol. ix, pp. 238–243.

Discusses the effect of simple expansion by increase of temperature in the production of lateral pressure in the earth's crust.

775 **Reese** (Charles L.). On the influence of swamp waters in the formation of the phosphate nodules of South Carolina.

Am. Jour. Sci., 3d ser., vol. xliii, pp. 402–406.

Brief description of the phosphate deposits and a statement of the results of certain chemical experiments.

776 **Reid** (Harry Fielding). Studies of Muir glacier, Alaska.

Nat. Geog. Mag., vol. iv, pp. 19-55, pls. i–xiv.

Abstract: Am. Geol., vol. x, p. 326 (⅓ p.).

Gives a general sketch of the geography of the country. Describes the main features of the glacier and its tributaries, and recites the evidences which indicate its former extension and recent diminution. Gives the results of measurements of the motion of the ice and the general features of its erosion.

777 **Reyer** (E.). On the causes of the deformation of the earth's crust.

Sci. Amer. Suppl., vol. xxxiv, pp. 13874–13875.

Discusses the effect of sedimentation and loading in producing deformation, illustrated by sketches of certain experiments.

778 **Rickard** (T. A.). The persistence of ores in lodes in depth.

Eng. and Min. Jour., vol. lv, pp. 51-52.

Remarks on the evidence of certain mines which indicate that the lodes becomes poorer when a considerable depth has been attained.

778*a* —— Certain dissimilar occurrences of gold-bearing quartz.

Colo. Sci. Soc., Proc., vol. iv, pp. 323–331 and 336–339.

Describes gold-bearing quartz veins of Australia, New Zealand, and California.

778*b* —— [Origin of ore deposits].

Colo. Sci. Soc., Proc., vol. iv, pp. 350–351.

In discussion of paper by P. H. van Diest on the "Evidence bearing on the formation of ore deposits by lateral secretion."

779 **Ricketts** (L. D.). Faulting in veins.

Eng. and Min. Jour., vol. liii, pp. 565–566.

Reviews the previous articles on this subject and discusses the characteristics of fault phenomena.

780 **Ries** (Heinrich). Notes on the clays of New York State and their economic value.

N. Y. Acad. Sci., Trans., vol. xii, pp. 40–47.

Describes the clays of Quaternary, Tertiary, and Cretaceous age occurring in various portions of the State.

781 —— List and bibliography of minerals occurring in Warwick Township, N. Y.

N. Y. Acad. Sci., Annals, vol. vii, pp. 651–654.

782 **Robertson** (James D.). Notes on the formation of the iron ores.

Science, vol. xxi, p. 131.

Describes an occurrence of specular hematite in Missouri and the evidences which indicate the replacement of limestone by iron from percolating waters.

783 **Rogers** (G. O.). Drift mounds near Olympia, Washington.

Am. Geol., vol. xi, pp. 393–399.

Describes some peculiar mounds occurring in this vicinity, reviews Professor Le Conte's theory as to their origin, and suggests that they are due to certain glacial phenomena.

784 **Rominger** (C.). On the occurrence of typical Chætetes in the Devonian strata at the falls of the Ohio and likewise in the analagous beds of the Eifel of Germany.

Am. Geol., vol. x, pp. 56–63.

Defines the characters which distinguish Chætetes from certain other genera and describes some specimens from the two localities.

785 **Ross** (O. C. D.). The origin of petroleum.

Brit. Assoc. Adv. Sci., Report 1891, pp. 639–641.

Refers to the occurrence of gypsum as being an indication of oil-bearing strata and to the general condition of the petroleum industry in the United States.

786 **Rothpletz** (A.). On the formation of oolite.

Am. Geol., vol. x, pp. 279–282.

Abstract: Am. Nat., vol. xxvii, p. 34 (⅜ p.).

Describes Glæocapsa and Glæothece cells found on the shores of Great Salt Lake. Describes the calcareous oolites, and concludes that a majority of the marine Cretaceous oolites, with regular zonal and radial structure, are of plant origin.

787 —— On the Permian, Triassic, and Jurassic formations in the East Indian Archipelago (Timor and Rotti).

Geol. Soc. Am., Bull., vol. iii, pp. 14–15.

Paper read before the society and discussed by C. A. White and Lester F. Ward.

788 **Rowley** (R. R.). Range of Choteau fossils.

Am. Geol., vol. xii, pp. 49–50.

Exhibits in tabular form the range of the common species of Choteau fossils in the Carboniferous of Missouri.

789 —— The Hamilton beds of Callaway County, Mo.

Am. Geol., vol. xii, pp. 203–205 (correspondence).

Gives list of fossils found in these beds.

790 —— Description of some new species of crinoids, blastoids, and brachiopods from the Devonian and sub-Carboniferous rocks of Missouri.

Am. Geol., vol. xii, pp. 303–309.

Describes new species from the Hamilton beds and Burlington, Choteau, and Louisiana limestones of Missouri.

791 **Ruffner** (W. H.). Some recent mineral discoveries in the State of Washington.

Science, vol. xix, p. 58.

Describes the ore deposits of different districts in the State.

792 **Russell** (F. W.). Notes upon Nebraska Tertiary.

Am. Geol., vol. ix, pp. 178–181.

Describes certain beds belonging to the Tertiary and discusses the evidences which indicate that some of them should be assigned to the Miocene and others to the Pliocene.

793 **Russell** (Israel C.). Malaspina Glacier.

Jour. of Geol., vol. i, pp. 219–245.

Abstract: Am. Geol., vol. xii, pp. 121–122 (⅜ p.).

Describes the geographic features of the Mount St. Elias region, illustrated by map, and the glacial characters of the ice sheet. Mentions the occurrence of forests on the moraines and of marginal lakes. The drainage is englacial or subglacial, and subglacial deposition takes place which may be similar to the osars of other glaciated regions.

794 —— Geological history of the Laurentian basin.

Jour. of Geol., vol. i, pp. 394–408.

Describes the sub-morainal topography of the basin. Discusses the origin of the basin, the character of its sediments, the evidences of the existence of lake shores, the fossils found in the sedimentaries, and the effect of a retreat of the ice sheet.

795 **Russell** (Israel C.). Correlation papers. The Newark system.

U. S. Geol. Surv., Bull. No. 85, 344 pp., pls. i–xiii, figs. 1–4.

Abstracts: Jour. of Geol., vol. i, pp. 740–744; Am. Geol., vol. xii, p. 402 (⅓ p.); Am. Nat., vol. xxvii, pp. 987–988.

Includes an account of the geographic distribution of the Newark system and a description of its lithologic character and stratigraphy, of the life of the period, and of the dikes and sheets of igneous rocks which penetrate the Newark strata. Contains a description of the structure and origin of the Newark areas, a discussion of the principles of correlation, the relation of the Newark to other systems, and a bibliography and index.

796 —— Second expedition to Mount St. Elias in 1891.

U. S. Geol. Surv., 13th Ann. Rept., part ii, pp. 7–91, pls. iii–xxi, figs. 1–6.

Describes the topographic features of the region and the character of the glacial phenomena and deposits.

797 —— A geological reconnoissance in central Washington.

U. S. Geol. Surv., Bull. No. 108, pp. 11–108, pls. i–xii, figs. 1–8.

Describes the character of the crystalline rocks, the Kittitas system, Columbia lavas, John Day system, and the glacial deposits. Discusses the geologic structure of the region and gives a description of the region traversed, including portions of Yakima, Kittitas, Okanogan, and Douglas counties.

798 —— Origin of the gravel deposits beneath Muir Glacier, Alaska.

Am. Geol., vol. ix, pp. 190–197.

Describes certain bowlder and gravel deposits on the west side of Yakutat Bay and assumes that similar deposits beneath Muir Glacier, described by H. P. Cushing, have a like origin.

799 —— Climatic changes indicated by the glaciers of North America.

Am. Geol., vol. ix, pp. 322–336.

Gives an account of the distribution of existing glaciers in North America and the evidences which indicate that they are now retreating. Concludes that the growth of glaciers and the initiation and decline of glacial epochs are the result of climatic changes so gradual as to require the lapse of centuries to become conspicuous.

800 —— Mount St. Elias and its glaciers.

Am. Jour. Sci., 3d ser., vol. xliii, pp. 169–182.

Abstract: Am. Geol., vol. ix, pp. 340–341.

Gives an account of two expeditions to the region and describes the character of the country traversed. The prevailing structure is monoclinal and similar to the Great Basin type. Describes the glacial phenomena and states that the present ice drainage is consequent on the orographic structure.

S.

801 **Safford** (James M.). Notes on the Middleton formation of Tennessee, Mississippi, and Alabama.

Geol. Soc. Am., Bull., vol. iii, pp. 511–512.

Abstract: Am. Geol., vol. xi, p. 119 (6 l.).

Describes the characters of the formations in these States which form the lowest Eocene.

802 —— The pelvis of a Megalonyx and other bones from Big Bone Cave, Tennessee.

Geol. Soc. Am., Bull., vol. iii, pp. 121–123.

Describes the pelvis and other bones found in this cave and its location and history.

803 **Safford** (James M.). Exhibition of certain bones of Megalonyx not before known.

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xl, p. 289 (⅓ p.)

804 —— The Tennessee Coal Measures.

U. S. Geol. Surv., Min. Res., 1892, pp. 497–506.

Describes the strata in which the Coal Measures occur and states that they form the uppermost beds of the Cumberland Plateau, covering an area of about 5,000 square miles.

805 **Sahlin** (Axel). The talc industry of the Gouverneur district, St. Lawrence County, N. Y.

Am. Inst. Min. Engrs., Trans., vol. xxi, pp. 583–588.

Briefly describes the occurrence of veins of talc in this district.

806 **Salisbury** (Rollin D.). On the probable existence of a second driftless area in the basin of the Mississippi.

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xl, pp. 251–253.

The area lies principally in Illinois, between the Mississippi and Illinois rivers. As the region is approached the topography loses the characteristics of glacial erosion and develops those of subaerial erosion.

807 —— A preliminary paper on drift or Pleistocene formations of New Jersey.

N. J. Geol. Surv., Report for 1891, pp. 35–108.

Gives a general description of the drift formations of the State and of the phenomena connected with their deposition. Describes the development and movements of the ice sheet in North America and the modifications produced on the pre-Glacial surface. Describes the deposits of till, the terminal moraines, and the extra-morainic glacial drift of New Jersey.

808 —— Certain extra-morainic drift phenomena of New Jersey.

Geol. Soc. Am., Bull., vol. iii, pp. 173–182.

Describes the deposits found in different localities which indicate that glaciation had extended beyond the limit heretofore assigned to it. It is suggested that the ice period may have been divided into three epochs, since the first advance has no frontal moraine, the second is limited by morainal ridges, and the third by terminal moraines of more pronounced character.

809 —— On the northward and eastward extension of the pre-Pleistocene gravels of the Mississippi basin.

Abstracts: Geol. Soc. Am., Bull., vol. iii, pp. 183–186.

Refers to previous publications by the author on the relationships of the Mississippi Valley gravels to the glacial drift and gives the results of recent observations. It is thought that the gravels are pre-Pleistocene and the gravels of the driftless area in Wisconsin and southeastern Minnesota are to be correlated with those of the Ohio and Mississippi basins.

810 —— Surface geology, Report of Progress, 1892 [New Jersey].

N. J. Geol. Surv., Report for 1892, pp. 37–166.

Abstract: Am. Geol., vol. xii, pp. 336–337.

Gives a general description of glacial deposits. Describes the till, extra-morainic till deposits, the terminal moraine, eskers, osars, kames, overwash plains and valley trains, Trenton gravels outside of Delaware Valley, glacial phenomena of glacial lake Passaic, wind drift and residuary products, and the yellow gravel in New Jersey.

811 **Salisbury** (Rollin D.). Distinct glacial epochs and the criteria for their recognition.

Jour. of Geol., vol. i, pp. 61–84.

Abstract: Am. Geol., vol. xi, pp. 171–172.

Defines the term "glacial epoch" and describes the phenomena which would indicate the existence of distinct glacial epochs.

812 —— The drift of the north German lowland.

Am. Geol., vol. ix, pp. 294–319.

Describes the differences of glacial phenomena of Germany and America and reviews the paper by Dr. F. Wahnschaffe on "The causes of the surface form of the north German lowland."

812*a* —— The Older drift in the Delaware valley.

Am. Geol., vol. xi, pp. 360–362 (correspondence).

Refers to article by A. A. Wright, on the same subject.

812*b* —— **Chamberlin** (T. C.) and. On the relationship of the Pleistocene to the pre-Pleistocene formations of the Mississippi basin south of the limit of glaciation.

See Chamberlin (T. C.) and Salisbury (R. D.), 132.

813 **Sapper** (Carl). Ueber die räumliche Anordnung der mexikanischen Vulkane.

Zeit. Deut. Geol. Gesell., Band xlv, Heft 4, 1893, pp. 574–577.

Describes the general arrangement and the structure and character of the materials of the volcanoes of Mexico.

814 —— Bemerkungen uber die räumliche Vertheilung und morphologischen Eigenthümlichkeiten der Vulcane Guatemalas.

Zeit. Deut. Geol. Gesell., Band xlv, Heft 1, 1893, pp. 54–62.

Describes the general character of volcanic activity in Guatemala and the arrangement and geographic distribution of the volcanoes. Considers they were formed by volcanic material coming up through fissures, the volcanoes varying in size according to the size of the fissure, and that their present form is due to the action of winds and hurricanes in carrying away the loose materials.

814*a* **Sardeson** (F. W.), **Hall** (C. W.) and. Paleozoic formations of southeastern Minnesota.

See Hall (C. W.) and Sardeson (F. W.), 377.

815 **Schuchert** (Charles). On the development of the skull of Zygospira recurvirostra.

Wash. Biol. Soc., Proc., vol. viii, pp. 79–82, pl. xi.

Describes specimens obtained from Minnesota from a horizon equivalent to the Trenton of New York and gives a statement of observations and correlations.

816 —— A classification of the Brachiopoda.

Am. Geol., vol. xi, pp. 141–167.

Reviews the classifications of Brachiopoda adopted by previous writers. Gives the author's classification and a table showing the geologic distribution of Brachiopoda.

816*a* —— **Beecher** (C. E.) and. Development of the brachial supports in Dielasma and Zygospira.

See Beecher (C. E.) and Schuchert (C.), 64.

816*b* **Schuchert** (Charles), **Winchell** (N. H.) and. Preliminary description of new Brachiopoda from the Trenton and Hudson River groups of Minnesota.

See Winchell (N. H.) and Schuchert (C.), 1081.

816*c* **Schwarz** (T. E.) [Independence mine, Cripple Creek, Colorado.]

Colo. Sci. Soc., Proc., vol. iv. p. 422.

Brief note on the occurrence of gold ores in this mine.

817 **Schweitzer** (Paul). A report on the mineral waters of Missouri.

Mo. Geol. Surv., vol. iii, 1892, pp. 1–256, pls. i–xxxiii, figs. 1–11.

Abstract: Am. Geol., vol. xi, pp. 205–207.

Discusses the origin of mineral waters and their analysis, composition and therapeutics. Describes the occurrences of mineral waters or brines, and the alkaline, sulphatic, chalybeate, and sulphur waters. Compares European and Missouri waters. Appendix B contains analyses of waters from most of the counties. Appendix C comprises a bibliography of mineral waters.

818 **Scott** (W. B.). On the osteology of Mesohippus and Leptomeryx, with observations on the modes and factors of evolution in the Mammalia.

Abstracts: Am. Geol., vol. ix, pp. 402–404; Am. Jour. Sci., 3d ser., vol. xliv, p. 428.

819 —— A revision of the North American Creodonta, with notes on some genera which have been referred to that group.

Phila. Acad. Nat. Sci., Proc., 1892, part ii, pp. 291–320, and part iii, pp. 321–323.

Reviews the classifications that have been previously proposed and describes several species.

820 —— The mammals of the Deep River beds.

Am. Nat., vol. xxvii, pp. 659–662.

Gives list of fossils found in Deep River Valley, Montana, with brief description of some new species.

821 **Scudder** (Samuel Hubbard). Index to the known fossil insects of the world, including myriapods and arachnids.

Abstract: Am. Jour. Sci., 3d ser., vol. xliii, pp. 244–245 (8 l.).

822 —— The Tertiary Rhynchophora of North America.

Boston Acad. Nat. Hist., Proc., vol. xxv, pp. 370–386.

Abstract: Am. Nat., vol. xxvii, pp. 146–147.

Gives a general account of the Tertiary insects and in tabular form compares the recent and fossils Rhynchophora, the relative importance of the families, and the relative abundance of insects in western deposits. Describes some of the different families.

823 —— Tertiary Rhynchophorous Coleoptera of the United States.

U. S. Geol. Surv., Monograph XXI, pp. 1–175, pls. i-xii.

Discusses the general results of the author's study of fossil Rhynchophora. Describes the characters of different species and gives a table showing their abundance and geographic distribution.

824 —— Some insects of special interest from Florissant, Colo., and other points in the Tertiaries of Colorado and Utah.

U. S. Geol. Surv., Bull. No. 93, 25 pp., pls. i-iii.

Abstract: Am. Nat., vol. xxvii, pp. 558–559 (⅓ p.).

Includes description of insects of different orders.

825 **Scudder** (Samuel Hubbard). The American Tertiary Aphidæ.

U. S. Geol. Surv., 13th Ann. Rept., part ii, pp. 347–356, pls. cii-cvi.

Describes the general characters of American fossil plant lice and gives a list of them and a brief description of various species and the locality where found.

826 —— Insect fauna of the Rhode Island coal field.

U. S. Geol. Surv., Bull. No. 101, pp. 9–21, pls. i-ii.

Describes specimens from the Carboniferous of Rhode Island.

827 **Sears** (John H.). Geological and mineralogical notes, No. 5.

Essex Inst., Bull., vol. xxv, pp. 8–13.

Abstract: Am. Nat., vol. xxvi, p. 156 (⅓ p.).

Describes some of the granitic, crystalline, and older sedimentary rocks of Essex County, Mass., and the microscopic structure of certain specimens.

828 —— On the occurrence of augite and nepheline syenites in Essex County, Mass.

Essex Inst., Bull., vol. xxv, pp. 111–125.

Describes the rock outcrops and the megascopic and microscopic characters of the syenites of the region.

829 **Selwyn** (Alfred R. C.). Summary report on the operations of the Geological Survey for the year 1890.

Can. Geol. Surv., Reports, vol. v, new series, 1890–91, part i, Report A, pp. 86.

Gives an account of observations on the gold-bearing rocks of Nova Scotia and of the Illecillewæt and Kootenai mining districts, and includes extracts from the reports of the assistant geologists.

830 —— Summary report on the operations of the Geological Survey for the year 1891.

Can. Geol. Surv., Reports, vol. v, new series, 1890–91, part ii, Report A, pp. 92.

Abstract: Am. Geol., vol. x, p. 182 (½ p.).

Includes an account of observations in Manitoba and Alberta and extracts from the reports of the geologic assistants.

831 —— Geological age of the Saganaga syenite.

Am. Jour. Sci., 3d ser., vol. xliii, pp. 319–322.

Refers to the paper by H. V. Winchell on the same subject. Discusses the use of the terms Huronian, Coutchiching, and Keewatin.

832 **Shaler** (Nathaniel Southgate). The origin and nature of soils.

U. S. Geol. Surv., 12th Ann. Rept., part i, pp. 219–345.

Abstract: Am. Jour. Sci., 3d ser., vol. xlv, pp. 163–164 (⅓ p.).

Discusses the nature and origin of soil and describes the processes of soil formation and certain peculiar soil conditions.

833 —— General account of the fresh-water morasses of the United States, with a description of the Dismal Swamp district of Virginia and North Carolina.

U. S. Geol. Surv., 10th Ann. Rept., pp. 255–339.

Abstract: Am. Geol., vol. ix, pp. 206–207.

Noticed in Record for 1891.

834 **Shaler** (Nathaniel Southgate). The geological history of harbors.

U. S. Geol. Surv., 13th Ann. Rept., part ii, pp. 99–209, pls. xxii–xlv, figs. 7–15.

Describes the general nature and origin of harbors, the effects of the forces at work upon them, and includes a description of the harbors on the Atlantic and Pacific coasts and on the Great Lakes of the United States.

835 —— The conditions of erosion beneath deep glaciers, based upon a study of the bowlder train from Iron Hill, Cumberland, R. I.

Harv. Mus. Comp. Zool., Bull., vol. xvi, No. 11, pp. 185–225, pls. i–iv, and map.

Abstracts: Am. Geol., vol. xii, pp. 191–192; Am. Nat., vol. xxvii, p. 662 ($\frac{1}{4}$ p.).

Describes the source of the bowlder train, its character and the rate of glacial erosion at this locality. Discusses the general characteristics of continental glaciation.

836 **Sherzer** (Will H.) A revision and monograph of the genus Chonophyllum.

Geol. Soc. Am., Bull., vol. iii, pp. 253–282.

Abstract: Am. Geol., vol. x, p. 66 ($\frac{1}{8}$ p.).

Describes the generic characters and gives a list of species of Chonophyllum. Its range is through Upper Silurian and the two lower divisions of the Devonian and reaching its maximum development in the Upper Helderberg.

837 **Shufeldt** (R. W.). A study of the fossil avifauna of the Silver Lake region, Oregon.

Phil. Acad. Nat. Sci., Jour., 2d ser., vol ix, pp. 389–425.

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xl, p. 286 (12 l.).

Describes some new forms of fossil gulls found in this region.

837*a* **Singley** (J. A.). Report for 1891.

Texas Geol. Surv., 2d Rept. of Progress, 1891, pp. 78–82.

Gives the section as shown by a deep well at Galveston.

838 —— Preliminary report on the artesian wells of the Gulf coastal slope.

Texas Geol. Surv., 4th Ann. Rept., pp. 87–113.

Gives the section displayed by the Galveston deep well to a depth of 3,070 feet and the names of the fossils found in the various fossiliferous beds. Includes a description of the artesian wells of the coastal prairie region and Tertiary belt, with chemical analyses of some of the waters and sections of many of the wells.

839 **Small** (H. B.). The phosphate mines of Canada.

Am. Inst. Min. Engrs., Trans., vol. xxi, pp. 774–782 and 1003.

Abstract: Eng. and Min. Jour., vol. lv, pp. 173–174.

Describes the apatite district in the Province of Quebec and the lithologic character of the rocks with which the apatite is associated.

840 **Smith** (Eugene A.). Underthrust folds and faults.

Am. Jour. Sci., 3d ser., vol. xlv, pp. 305-306.

Describes the typical Appalachian fold and the structure of the underthrust fold or fault.

841 **Smith** (Eugene A.). Phosphates and marls of Alabama.

Ala. Geol. Surv., Bull. No. 2, pp. 9-82.

Abstract: Am. Nat., vol. xxvi, pp. 1026–1027.

Describes the characteristics of the subdivisions of the Cretaceous and Tertiary formations of the State and their contained phosphate deposits and calcareous marls. Gives a statement of the quality of the Alabama materials and compares them with the New Jersey phosphatic marls.

842 —— Sketch of the geology of Alabama.

Roberts & Son, Birmingham, Ala., pp. 1–36.

Describes the characteristics of each of the geologic formations occurring in the State, which includes representatives of all formations from Archean to Recent, except the Permian, Triassic, and Jurassic. Gives an account of their geographic distribution and a description of their economic mineral constituents.

843 —— The Coal Measures of Alabama.

U. S. Geol. Surv., Min. Res., 1892, pp. 293–300.

Divides the coal fields into three districts. States that they were probably originally continuous, but have been disconnected by dynamic forces.

844 **Smith** (Hamilton L.). List of species and some notes upon them.

Minn. Geol. and Nat. Hist. Surv., 20th Ann. Rept., pp. 293–306.

Contains notice of the discovery of a peat deposit of Minnesota carrying fresh-water forms, which occurs between layers of bowlder clay, and contain a marine fauna. Gives a list of diatoms found in the peat, with notes on the species.

845 **Smith** (W. Hampton). Ancient glacial moraine and drift at the mouth of the Columbia River.

Sci. Amer. Suppl., vol. xxxvi, p. 14658.

Describes and illustrates by cross-sections the structure and character of a mass of glacial débris occurring beneath a series of sandstones and shales 800 to 900 feet in thickness.

846 **Smith** (W. H. C.). Report on the geology of Hunters Island and adjacent country.

Can. Geol. Surv., Reports, vol. v, new series, 1890–91, part i, Report G, 76 pp.

Reviews the work of previous years and gives a bibliography of the geologic literature pertaining to this field. Describes its physical and geologic features. The rocks are schists, quart-porphyries, and conglomerates, associated with altered volcanics and rocks of granitic and syenitic types, the latter exhibiting evidences of eruptive origin.

847 —— The Archean rocks west of Lake Superior.

Geol. Soc. Am., Bull., vol. iv., pp. 333–348.

Describes the character and relations of the Laurentian rocks and discusses the relation of the Coutchiching and Keewatin series to the Laurentian granites. Describes the character and extent of the Coutchiching, Keewatin, and Steep Rock series, with a brief description of the gold deposits and iron ores.

848 **Smock** (John C.). Annual report of State Geologist, 1892.

N. J. Geol. Surv., Report for 1892, pp. 3–30.

Gives an account of the work accomplished in ascertaining the character and extent of Pleistocene, Tertiary, and Cretaceous formations of New Jersey.

849 **Smyth** (C. H., jr.). Lake filling in the Adirondack region.

Am. Geol., vol. xi, pp. 85–90.

Describes the filling of several small lakes which were formed originally by the damming up of old drainage lines by glacial débris. Concludes that the obliteration of the lakes is due to sedimentation, and not to the cutting down of their outlets.

850 —— A geological reconnoissance in the vicinity of Gouverneur, N.Y.

N. Y. Acad. Sci., Trans., vol. xii, pp. 97–108.

Describes the topography and geologic features of the region. Discusses the relation of the limestone to gneiss and the effects of metamorphism.

851 —— Petrography of the gneisses of the town of Gouverneur, N. Y.

N. Y. Acad. Sci., Trans., vol. xii, pp. 203–217.

Describes the petrographic characters of the gneiss, granite, crystalline limestone, quartzite, pyroxene rocks and scapolite rocks of this region, mentioned in a previous article on "A geological reconnoissance in the vicinity of Gouverneur, N. Y."

852 —— A third occurrence of peridotite in central New York.

Am. Jour. Sci., 3d ser., vol. xliii, pp. 322–327.

Description of the strata in which the peridotite occurs and of its mineralogic, chemical, and microscopic characteristics.

853 —— On the Clinton iron ore.

Am. Jour. Sci., 3d ser., vol. xliii, pp. 487–496.

Abstract: Am. Geol., vol. x, pp. 122–124.

Describes the iron ore deposits occurring at Clinton, N. Y., and concludes that these deposits are not of secondary origin, but were deposited as hydrated peroxides of iron in partially inclosed basins of the Silurian sea.

854 —— Alnoite containing an uncommon variety of melilite.

Am. Jour. Sci., 3d ser., vol. xlvi, pp. 104–107.

Describes some thin sections of a dike rock from New York containing this mineral.

855 **Smyth** (Henry Lloyd). A contact between the Lower Huronian and the underlying granite in the Republic trough, near Republic, Mich.

Jour. of Geol., vol. i, pp. 268–274.

Describes the general relations and characteristics of the formations in this locality and the contact phenomena at the point where exposed.

856 **Snow** (Charles H.). Copper crystallizations at the Copper Glance and Potosi mines, Grant County, New Mexico.

Am. Inst. Min. Engrs., Trans., vol. xxi, pp. 308–313.

Gives a sketch of the geologic structure of the Copper Glance and Potosi ore bodies, with a description of the occurrence of some copper crystalline forms. Illustrated by sketch of the specimens.

857 **Spencer** (J. W.). The Paleozoic group. The geology of ten counties of northwestern Georgia.

Ga. Geol. Surv., 1893, pp. 1–406.

Abstracts: Am. Geol., vol. xii, pp. 267–268; Am. Nat., vol. xxvii, p. 1078 (½ p.).

Describes the general characteristics of the Cambrian, Silurian, Devonian, and Carboniferous formations and the physical features of this region. Gives an account of the local geology of each of the ten counties and a description of the ore deposits of iron, manganese, aluminum, coal, and building stones.

858 **Spencer** (J. W.). The Iroquois shore north of the Adirondacks.

Geol. Soc. Am., Bull., vol. iii, pp. 488-491.

Abstract: Am. Geol., vol. xi, p. 58 (¼ p.).

Describes in detail the shore-line. Considers that the accumulations at the mouths of all old valleys are identical with the Iroquois beach.

859 —— Channels over divides not evidence per se of glacial lakes.

Geol. Soc. Am., Bull., vol. iii, pp. 491–492.

Abstract: Am. Geol., vol. xi, p. 58 (⅛ p.).

Describes the valley of Black River, New York, and the character of the terraces, and considers that those on the south indicate the insufficiency of ice dams to account for such high level terraces. Discussed by G. K. Gilbert, I. C. Russell, and the author.

859*a* **Springer** (Frank), **Wachsmuth** (C.) and. Description of two new genera and eight species of camerate crinoids from the Niagara group.

See Wachsmuth (C.) and Springer (F.), 974.

860 **Stanley-Brown** (Joseph). Geology of the Pribilof Islands.

Geol. Soc. Am., Bull. vol. iii, pp. 496–500.

Abstract: Am. Geol., vol. xi, p. 57 (½ p.).

The islands were formed by recent volcanic action, marked by three distinct stages, whose contacts can be distinctly recognized. Describes the general character of and changes caused by igneous action.

861 **Stanton** (Timothy W.). The Colorado formation and its invertebrate fauna.

U. S. Geol. Surv., Bull. No. 106, pp. 13–189, pls. i-xlv.

Describes the geographic distribution of the formation, its lithologic characters, and thickness at different localities, with lists of fossils collected. Compares its fauna with other Cretaceous faunas of North America and Europe, and describes the characters of different species, stating the locality where found and their geologic position.

862 —— The stratigraphic position of the Bear River formation

Am. Jour. Sci., 3d ser., vol. xliii, pp. 98–115.

Abstract: Am. Geol., vol. ix, pp. 266–267.

Gives detailed description of the geologic sections at Bear River City and vicinity, in western Wyoming, and shows that this formation, formerly considered to be of Laramie or later age, is intermediate between the Jurassic and Colorado Cretaceous and probably above the Dakota. Of its thirty species of molluscan remains none have been found in the true Laramie. Accompanied by map and four sections.

863 —— The faunas of the Shasta and Chico formations.

Geol. Soc. Am., Bull., vol. iv, pp. 245–256.

Abstract: Am. Geol., vol. xii, p. 120 (⅛ p.).

Reviews the literature on the relations of these formations, gives a list of both faunas from northern California, and reviews the evidences correlating these beds with the Queen Charlotte series of British Columbia. Concludes that there is no faunal break in the Shasta-Chico series.

864 **Stefanescu** (Grégoire). On the existence of the Dinotherium in Roumania.

Geol. Soc. Am., Bull., vol. iii, pp. 81–83.

Mentions the occurrence of remains of large Mammalia in the Tertiary and Quaternary of this country. Describes and illustrates the beds in which fragments of Dinotherium were found and gives measurements of some of its parts.

865 **Steinmann** (Gustav). A geological map of South America.

Abstract: Geol. Soc. Am., Bull., vol. iii, pp. 13–14.

The paper was discussed by E. D. Cope, R. T. Hill, and C. A. White.

866 **Stevenson** (John J.). The Chemung and Catskill (Upper Devonian) on the eastern side of the Appalachian basin.

Am. Assoc. Adv. Sci., Proc., vol. xl, pp. 219–247; Am. Geol., vol. ix, pp. 6–33.

Abstract: Am. Nat., vol. xxvi, p. 157 (⅛ p.).

Reviews the opinions of other writers concerning the geologic position of these beds and describes their structural characteristics. Concludes that the series from the Portage to the end of the Catskill forms one period, the Chemung, and should be considered as belonging to the Devonian.

867 —— On the use of the name "Catskill."

Am. Jour. Sci., 3d ser., vol. xlvi, pp. 330–337.

Discusses the applicability of the term "Catskill" to designate an important formation and describes the general relations and character of the strata to which it is applied.

868 —— Prof. I. C. White's "Stratigraphy of the bituminous coal fields of Pennsylvania, Ohio, and West Virginia."

Am. Geol., vol. ix, pp. 352–355.

Gives a general review of the paper by Professor White.

869 —— On the origin of the Pennsylvania anthracites.

Abstract: Jour. of Geol., vol. i, pp. 677–687.

Discusses the different theories advanced to account for the occurrence of anthracite and gives a brief statement concerning the author's hypothesis.

870 **Stevenson** (Robert). The persistence of ores in lodes in depth.

Eng. and Min. Jour., vol. lv, p. 148.

Remarks on some evidences of barrenness and pinching out of ore bodies in mines of California at depths of 30 to 60 feet and widening out again within 25 feet of the bottom of the shaft.

871 **Stoek** (H. H.). Notes on the iron ores of Danville, Pa., with a description of the long-wall method of mining used in working them.

Am. Inst. Min. Engrs., Trans., vol. xx, pp. 369–385.

Gives a brief geologic description of the region and reproduces a section made by H. D. Rogers. The ore is of two varieties, one occurring in limestones, the other in sandstones. Includes analyses of the ores and a history of the development of the mines and the mining methods employed.

872 **Stone** (George H.). The osar gravels of the coast of Maine.

Jour. of Geol., vol. i, pp. 246–254.

Abstracts: Am. Geol., vol. xii, p. 122 (⅛ p.); Am. Geol., vol. xii, pp. 200–203 (correspondence).

Describes the osars of the region and remarks on the decrease in size of the gravel masses toward the coast and the presence of subglacial streams as shown by the occurrence of glacial potholes, and discusses the origin of the subglacial tunnels.

873 **Stone** (George H.). An extinct glacier of the Salmon River Range.

Am. Geol., vol. xi, pp. 406–409.

Describes an extinct glacier occurring in the Salmon River Mountains of Idaho.

874 —— The Turkey Creek mining district, El Paso County, Colo.

Eng. and Min. Jour., vol. lvi, p. 262.

Describes the occurrence of sandstone in granite, with brief statement concerning the other rocks of the district.

875 —— The Las Animas glacier.

Jour. of Geol., vol. i, pp. 471–475.

Describes the deposits of this extinct glacier and its tributaries in the smaller valleys.

876 **Storms** (W. H.). Los Angeles County [California].

Cal. State Min. Bur., 11th Rept., pp. 243–248.

Notes on the character and manner of occurrence of the gold and silver ores in certain mines.

877 —— San Bernardino County [California].

Cal. State Min. Bur., 11th Rept., pp. 337–369.

Describes the geologic features and the structure and character of the ore deposits of the Calico mining district and other mining districts of the county.

878 —— San Diego County [California].

Cal. State Min. Bur., 11th Rept., pp. 376–387.

Notes on some of the gold mines.

879 **Streeruwitz** (W. H. von). Report for 1891.

Texas Geol. Surv., 2d Rept. of Progress, 1891, pp. 20–26.

Gives an account of the general and economic geology of the Carrizo and Sierra Diablo mountains.

880 —— Trans-Pecos Texas.

Texas Geol. Surv., 3d Ann. Rept., 1891, pp. 383–389.

Contains brief description of the Carboniferous and Cretaceous beds in this region and the indications of ore bodies in the Carrizo and Sierra Diablo mountains.

881 —— Trans-Pecos Texas.

Texas Geol. Surv., 4th Ann. Rept., pp. 141–175.

Describes the processes of subaerial erosion in this region and contains observations on the occurrence of silver and gold and on outcrops showing lead or copper. Describes the Cretaceous and Carboniferous strata and gives a measured section in the Sierra Diablo and Carrizo mountains and a list of fossils obtained.

882 —— On the precious and other valuable metals of Texas.

Texas Acad. Sci., Trans., vol. i, pp. 19–24.

Gives a brief description of the occurrence of gold, silver, and platinum and their distribution and that of iron in the several districts of Texas.

883 —— The non-metallic mineral resources of the State of Texas.

Texas Acad. Sci., Trans., vol. i, pp. 97–102.

Discusses the character of the brown and stone coals, fire clays, kaolin, salt deposits, and building stones of Texas.

884 **Stretch** (R. H.). The Monte Christo mining district, Washington.
Eng. and Min. Jour., vol. lv, p. 343.
Describes the topographic and geologic features of the region.

885 **Swezey** (G. D.). Evidence of two pre-morainic glacial movements.
Science, vol. xxi, p. 216.
Describes some glacial phenomena of Nebraska.

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886 **Taff** (J. A.). Report for 1891.
Texas Geol. Surv., 2d Rept. of Progress, 1891, pp. 70–77.
Describes the artesian water supply and mineral resources of central and southwest Texas.

887 —— Report on the Cretaceous area north of the Colorado River.
Texas Geol. Surv., 3d Ann. Rept., pp. 269–379.
Describes the geologic and petrographic features of the Cretaceous series and mentions some of the fossils found in them. Divides the report into two sections—the Bosque, which is the lowest of the Cretaceous in Texas, and the Lampasas-Williamson section, the latter comprising the whole Cretaceous in central Texas.

888 —— Report on the Cretaceous area north of the Colorado River.
Texas Geol. Surv., 4th Ann. Rept. pp. 241–354.
Continues the description of Cretaceous deposits contained in Third Annual Report for 1891. Discusses the artesian water problems and describes the soils and topographic features of the region. Accompanied by two maps showing the areal extent of the Cretaceous and the artesian water conditions.

889 —— [Reply to criticisms on Third Annual Report of the Geological Survey of Texas.]
Am. Geol., vol. xi, pp. 128–130 (correspondence).

890 **Talmage** (J. E.). A remarkable occurrence of selenite.
Science, vol. xxi, pp. 85–86.
Abstract: Am. Nat., vol. xxvii, p. 1091 (¼ p.).
Describes an occurrence of gypsum in a cave in southern Utah. Contains illustrations of the crystals as they occur in place.

891 **Tarr** (Ralph S.). The Permian of Texas.
Am. Jour. Sci., 3d ser., vol. xliii, pp. 9–12.
Considers, from the lithologic character and fauna, that the Permian of western Texas was deposited in a shallow inclosed sea and separated from the Carboniferous, if at all, by a very slight time-break.

892 —— The central Massachusetts moraine.
Am. Jour. Sci., 3d ser., vol. xliii, pp. 141–145.
Describes the moraine as extending from Cape Ann nearly to the Connecticut River. The halt in the retreat of the ice was only of sufficient length to form a well-defined morainal band.

893 —— A hint with respect to the origin of terraces in glaciated regions.
Am. Jour. Sci., 3d ser., vol. xliv, pp. 59–61.
Describes the valley of the Colorado River in central Texas and states that the conditions here prevailing are practically similar to those at the time of the formation of the terraces of the Glacial epoch. Compares the Colorado River terraces with those of the Connecticut River.

894 **Tarr** (Ralph S.). The Glacial period.

Sci. Am., vol. lxviii, pp. 86 and 103.

Describes the glacial phenomena in North America and other countries and discusses the evidences indicating the length of time since the close of the Glacial period.

895 —— Extinct volcanoes in the United States.

Sci. Am. Suppl., vol. xxxvi, pp. 14657–14658.

Describes some extinct volcanoes found in the Sierra Nevada, Coast Ranges, and Appalachians.

896 —— The new physical geography.

Sci. Am. Suppl., vol. xxxvi, pp. 14975–14976.

Remarks on the interdependence of geography and geology and describes some processes of stream erosion.

897 —— The Cretaceous covering of the Texas Paleozoic.

Am. Geol., vol. ix, pp. 169–178.

Gives a general sketch of the geologic history of Texas from the Carboniferous to and including Cretaceous time, indicating that it was uninterruptedly a land area and toward the close of the period had become a base-leveled peneplain, over which the Cretaceous sea rapidly encroached.

898 —— The relation of secular decay of rocks to the formation of sediments.

Am. Geol., vol. x, pp. 25-44.

Describes the processes of secular disintegration of rocks, the formation and distribution of residual soils, and the forces which transport the products of rock decay and assist in rock formation.

899 —— Glacial erosion.

Am. Geol., vol. xii, pp. 147–152.

Describes the general characteristics of glacial erosion and discusses the possibility of estimating the rate of glacial erosion from a study of these features.

900 —— Notes on the physical geography of Texas.

Phila. Acad. Nat. Sci., Proc., 1893, part ii, pp. 313–347.

Describes the present topographic features and also those of the different geologic periods in various portions of the State, with a discussion of the base-leveling and changes in the drainage systems that have taken place.

901 —— Reconnoissance of the Guadalupe Mountains.

Texas Geol. Surv., Bull. No. 3, pp. 9–42.

Describes the Cretaceous, Permian and Carboniferous areas of central Texas, the topographic features of the Guadalupe Mountains, their stratigraphy and economic resources.

902 —— **Wolff** (J. E.) and. Acmite-trachyte from the Crazy Mountains, Montana.

See Wolff (J. E.) and Tarr (R. S.), 1093.

903 **Taylor** (F. B.). The highest old shore-line on Mackinac Island.

Am. Jour. Sci., 3d ser., vol. xliii, pp. 210-218.

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xl, pp. 260–261.

Discusses the evidences as to the altitude of the highest shore-line on this island and at other points in the region and suggests a provisional classification of the deserted beaches of the Great Lakes into two subdivisions, differing genetically and chronologically from each other.

903*a* **Texas Geological Survey.** Annual Report for 1891.

Abstracts: Am. Jour. Sci., 3d ser., vol. xliv, p. 427 (½ p.); Am. Geol., vol. x, pp. 311–316.

903*b* **Texas Geological Survey.** Annual Report for 1892.

Abstract: Am. Jour. Sci., 3d ser., vol. xlvi, pp. 307–308.

904 **Thomas** (Benj. W.). Diatomaceæ of Minnesota interglacial peat.

Minn. Geol. and Nat. Hist. Surv., 20th Ann. Rept., pp. 290–293.

Contains a description of Diatomaceæ and their geologic and geographic distribution.

905 **Thompson** (Maurice). Drift beds of Indiana.

Ind. Dept. Geol. and Nat. Hist., 16th Rept., 1888, pp. 20–40.

Describes the modification of the drift since its deposition and discusses the theory of a "second glacial epoch." Describes the depth and structure of the drift deposits and their contained fossils and minerals.

906 —— The Wabash arch [Indiana].

Ind. Dept. Geol. and Nat. Hist., 16th Rept., 1888, pp. 41–53.

Gives an account of observations bearing on the formation and structure of the arch and considers that it was connected with a continental disturbance occurring about the close of the Niagara epoch.

907 —— Gold, silver, and precious stones [Indiana].

Ind. Dept. Geol. and Nat. Hist., 16th Rept., 1888, pp. 87–92.

Describes the characteristics and manner of occurrence of these metals and states that none of them are to be found in Indiana.

908 —— The formation of soils and other superficial deposits [Indiana].

Ind. Dept. Geol. and Nat. Hist., 16th Rept., 1888, pp. 93–97.

Describes the composition and mode of formation of the black prairie and some of the clay soils of the State.

909 —— Indiana building stones.

Ind. Dept. Geol. and Nat. Hist., 17th Rept., 1891, pp. 19–113.

Describes the sandstones and limestones of Silurian, Devonian, and Carboniferous ages in the State, with an account of the quarrying industry and a list of the quarries.

910 —— Geological and natural history report of Carroll County [Indiana].

Ind. Dept. Geol. and Nat. Hist., 17th Rept., 1891, pp. 171–191.

Describes the topographic features and soil characteristics and discusses the disturbance of the Niagara limestone in this county.

911 **Thompson** (R. A.). Report on the soils, water supply, and irrigation of the Colorado coal field [Texas].

Texas Geol. Surv., 4th Ann. Rept., pp. 449–481.

Describes the characters of the various soils, giving chemical analyses, water supply, and irrigation possibilities of the region.

912 **Thompson** (W. H.). Fossils and their value.

Ind. Dept. Geol. and Nat. Hist., 16th Rept., 1888, pp. 54–76.

Describes the nature and distribution of fossils, how to collect them, and the fossil beds of Indiana, and gives a list of fossils found at Crawfordsville, Ind., by Charles Beechler.

913 —— Outline sketch of the most valuable minerals of Indiana.

Ind. Dept. Geol. and Nat. Hist., 16th Rept., 1888, pp. 77–86.

Describes the deposits of kaolin, the building stones, coals, iron ores, and beds of lime and chalk.

914 **Thompson** (W. H.). Partial report of survey of the western division, including sketches of Pulaski and White counties, Indiana.

Ind. Dept. Geol. and Nat. Hist., 16th Rept., 1888, pp. 131–154.

Includes description of the structural features of the Silurian and Devonian formations and the planing accomplished by the ice sheet in this region.

915 **Tiffany** (A. S.). Ancient waterways.

Abstract: Geol. Soc. Am., Bull., vol. iv, pp. 10–11.

916 **Tilton** (J. L.). Strata between Ford and Winterset [Iowa].

Iowa Acad. Sci., Proc., vol. i, part iii, pp. 26–27.

Notes on the Coal Measures of this region in Iowa.

917 **Todd** (J. E.). Striation of rocks by river ice.

Am. Geol., vol. ix, pp. 396–400.

Iowa Acad. Sci., Proc., vol. i, part ii, pp. 19–20.

Describes occurrences of striation by river ice below the glaciated area and considers that planation and striation are sometimes the work of river ice armed with erratics.

918 —— Volcanic dust from Omaha, Nebr.

Am. Geol., vol. x, pp. 295–296.

Iowa Acad. Sci., Proc., vol. i, part ii, p. 16.

Describes the deposit and gives a vertical section of the bluff in which it outcrops.

919 —— The shore-lines of ancient glacial lakes.

Am. Geol., vol. x, pp. 298–302.

Iowa Acad. Sci., Proc., vol. i, part ii, pp. 17–19.

Discusses the causes of the obscurity of shore-lines of glacial lakes and gives the results of recent observations in the region of the Moreau and Big Cheyenne rivers.

920 —— Striæ and slickensides at Alton, Ill.

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xl, pp. 254–255.

Describes the locality and states that the striæ seem to pass into slickensides and may be due to a force acting in a horizontal direction.

921 —— Further note on the Loup and Platte rivers.

Science, vol. xix, pp. 148–149.

Additional notes concerning the topography and drainage of these rivers.

922 —— The Quaternary geology.

Mo. Geol. Surv., Higginsville sheet, pp. 10–11.

Describes the deposits of the drift, loess, or upland loam, and the terraces and bottoms in the area of the Higginsville sheet.

923 —— Notes on the geology of northwestern Iowa.

Iowa Acad. Sci., Proc., vol. i, part ii, pp. 13–16.

Gives data bearing on the geology of the region obtained from well records.

924 **Topley** (W.). The geology of petroleum and natural gas.

Brit. Assoc. Adv. Sci., Report for 1891, pp. 637–639.

Refers to the oil and gas fields of the United States and describes the formations in which they occur.

925 **Turner** (H. W.). Glacial potholes in California.

Am. Jour. Sci., 3d ser., vol. xliv, pp. 453–454.

Describes the potholes, and states that they were probably formed by the action of water in some way connected with the glacier that formerly filled the canyon.

926 —— The lavas of Mount Ingalls, California.

Am. Jour. Sci., 3d ser., vol. xliv, pp. 455–459.

Describes the occurrence and characteristics of the four varieties of eruptive rocks found in this locality and gives two analyses of the basalt.

927 —— The coal deposits of California.

U. S. Geol. Surv., Min. Res., 1892, pp. 308–310.

The coal measures that have produced the largest quantity of coal belong to the Eocene formation. Coal also occurs along the foothills of the Sierra Nevada, in the Ione formation, which is considered to be of Miocene age.

928 —— Some recent contributions to the geology of California.

Am. Geol., vol. xi, pp. 307–324.

Reviews several papers which treat of the geology of portions of California.

929 **Tyrrell** (J. B.). Report on northwestern Manitoba, with portions of the adjacent districts of Assiniboia and Saskatchewan.

Can. Geol. Surv., Reports, vol. v, new series, 1890–91, part i, Report E, pp. 231.

Describes the physical features of the region, with statistics of temperature and precipitation. The formations represented comprise the Silurian, Devonian, Cretaceous, post-Tertiary, and Recent. Several sections are given and lists of fossils from many localities. Salt obtained from brine springs forms the chief economic product of geologic interest.

930 —— Deep well at Deloraine, Manitoba.

Am. Geol., vol. xi, pp, 332–342.

Gives the section displayed by the well to a depth of 1,943 feet and describes the lithologic character of the deposits penetrated and mentions the fossils found.

U.

931 **Udden** (J. A.). On a natural formation of pellets.

Am. Geol., vol. xi, pp. 268–271.

Describes the formation of round white pellets in a deposit of volcanic dust occurring in McPherson County, Kans.

932 **Uhler** (P. R.). Gay Head.

Science, vol. xx, pp. 176–177.

General description of the geology of this locality.

933 —— Observations on the Cretaceous at Gay Head.

Science, vol. xx, pp. 373–374.

Gives the results of observations in this locality.

934 **Ulke** (Titus). A new tin mineral in the Black Hills.

Am. Inst. Min. Engrs., Trans., vol. xxi, pp. 240–241.

Describes the character of a new mineral which the author names cuprocassiterite.

935 **Ulke** (Titus). A contribution to the geology of the Dakota tin mines.

Eng. and Min. Jour., vol. liii, p. 547.

Includes brief description of the Archean rocks in which tin occurs, the mineral species found, and a discussion as to the origin of the tin-bearing granites.

936 —— The occurrence of tin ore at Kings Mountain, N. C., and near Vesuvius, Va.

U. S. Geol. Surv., Min. Res., 1893, pp. 178–182.

Describes the character of the country rock of the two localities and the manner of occurrence of the tin ore.

937 **Ulrich** (E. O.). New Lamellibranchiata.

Am. Geol., vol. x, pp. 96–104.

Describes one new genus and eight new species found in shaly strata equivalent to the Black River limestone, in Minnesota.

938 —— New Lower Silurian Ostracoda, No. 1.

Am. Geol., vol. x, pp. 263–270.

Describes some minute Paleozoic fossils which represent recognizable stages in the development of Leperditiidæ.

939 —— Two new Lower Silurian species of Lichas (subgenus Hoplolichas).

Am. Geol., vol. x, pp. 271–272.

Describes two new species from Minnesota.

940 —— New Lower Silurian Lamellibranchiata, chiefly from Minnesota rocks.

Minn. Geol. and Nat. Hist. Surv., 19th Ann. Rept., pp. 211–248.

Abstract: Am. Jour. Sci., 3d ser., vol. xliv, p. 79 ($\frac{1}{3}$ p.).

Names many forms of Lamellibranchiata found in the different horizons of the Lower Silurian, discusses their classification, and describes some of the forms.

940*a* **United States Geological Survey.** Tenth Annual Report.

Abstracts: Am. Jour. Sci., 3d ser., vol. xliii, pp. 155–156; Am. Geol., vol. ix, pp. 337–340.

940*b* —— Eleventh Annual Report.

Abstract: Am. Geol., vol. xii, pp. 259–260.

941 **Upham** (Warren). [Pleistocene climatic changes.]

Abstract: Am. Geol., vol. xii, pp. 228–229.

Paper read before the World's Congress of Geology.

942 —— Altitude as the cause of the Glacial period.

Science, vol. xxii, pp. 75–76.

Reviews some of the theories as to the cause of the Ice age and the evidences which indicate a high altitude as the cause of the climatic changes.

943 —— Estimates of geologic time.

Am. Jour. Sci., 3d ser., vol. xlv, pp. 209–220; Sci. Am. Suppl., vol. xxxv, pp. 14403–14405.

Abstracts: Jour. of Geol., vol. i, pp. 203–204; Am. Geol., vol. xi, p. 413 ($\frac{2}{3}$ p.).

Reviews the estimates of earth age and the time ratios adopted by different writers and the evidences on which they are based.

944 **Upham** (Warren). Epeirogenic movements associated with glaciation.

Am. Jour. Sci., 3d ser., vol. xlvi, pp. 114–121.

Discusses the evidence of deep submarine valleys eroded in late Tertiary and Quaternary time and its bearing on the theory of epeirogenic movements as the cause of the Glacial epoch.

945 —— Conditions of accumulation of drumlins.

Am. Geol., vol. x, pp. 339–362.

Abstract: Am. Jour. Sci., 3d ser., vol. xlv, pp. 70–71.

Defines and describes the varieties of drumlins. Outlines their geographic distribution, and states that they are probably the accumulation from englacial drift. Discusses the question of the unity of the Glacial epoch.

946 —— Englacial drift.

Am. Geol., vol. xii, pp. 36–43.

Discusses the use and application of the term "englacial drift," the distinction between subglacial till and the ice-inclosed drift, and the evidence showing that the drift is carried only into the lower part of the ice sheet. Considers that englacial drift becomes superglacial by the superficial melting of the ice and not by the gradual movement of the ice currents from the bottom to the ice surface.

947 —— Eskers near Rochester, N. Y. A discussion of the structure and origin of the Pinnacle Hills.

Roch. Acad. Sci., Proc., vol. ii, pp. 181–200.

Describes the structure of the Pinnacle Hills and eskers in Pittsford and discusses their relationship to glacial movements and their probable origin.

948 —— Processes of mountain building and their relationship to the earth's contraction.

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xl, pp. 274–279.

Classifies mountain building forces into: first, that of folding; second, that form of energy acting in a vertical direction which has produced the arched, domed, tilted, and erupted forms. Both appear to be due to the earth's contracting in cooling, and the latter is dependent on the former in the occasional relief of stress by folding along mountain ranges.

949 —— A classification of mountain ranges according to their structure, origin, and age.

Appalachia, vol. vi, pp. 191–207.

Abstracts: Am. Jour. Sci., 3d ser., vol. xliii, pp. 74–75 (½ p.); Am. Geol., vol. ix, pp. 205–206.

Noticed in Record for 1891.

950 —— Submarine valleys on continental slopes.

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xli, pp. 171–173.

Describes submarine valleys in different parts of the world and compares their depths with that of the adjoining ocean level.

951 —— Inequality of distribution of englacial drift.

Geol. Soc. Am., Bull., vol. iii, pp. 134–148.

Describes the deposition of englacial drift and the region in which abundant and scanty deposition occurred. Discusses the relationship of the englacial drift to the terminal moraines and the forms in which the former were laid down.

952 **Upham** (Warren). Relationship of the glacial lakes Warren, Algonquin, Iroquois, and Hudson-Champlain.

Abstracts: Geol. Soc. Am., Bull., vol. iii, pp. 484–487; Am. Geol., vol. xi, p. 59 (¾ p.).

Describes the character and extent of the lake basins mentioned and in a general way defines their shore-lines.

953 —— The Champlain submergence.

Abstracts: Geol. Soc. Am., Bull., vol. iii, pp. 508–511; Am. Geol., vol. xi, p. 119 (⅜ p.).

Discusses the evidences of a submergence in Champlain time in eastern North America.

954 —— [Connecticut Valley glacier.]

Geol. Soc. Am., Bull., vol. iv, p. 6.

In discussion of paper by C. H. Hitchcock, "Studies of the Connecticut Valley glacier."

955 —— Comparison of Pleistocene and present ice sheets.

Geol. Soc. Am., Bull., vol. iv, pp. 191–204.

Abstract: Am. Geol., vol. xii, p. 119 (½ p.).

Describes the existing ice sheets and glaciers and discusses the character and extent of the Pleistocene ice sheets from a comparison with present ice sheets, the continuity of the Ice age and the probable synchronism of glaciation in North America and Europe.

956 —— [The occurrence of Yoldia arctica in bowlder-clay.]

Geol. Soc. Am., Bull., vol. iv, p. 370.

In discussion of paper by R. Chalmers, "Height of Bay of Fundy coast in the Glacial period relative to sea-level as evidenced by marine fossils in the bowlder-clay at St. John, New Brunswick."

957 —— Drumlins near Boston.

Appalachia, vol. vii, pp. 39–48.

Refers to the earlier descriptions of drumlins in this vicinity, gives a list of papers treating on the drumlins near Boston, and discusses the theories as to their origin.

958 —— A recent visit to Lake Itasca.

Minn. Acad. Nat. Sci., Bull., vol. iii, pp. 284–292.

Gives an account of some glacial phenomena in this region.

959 —— Recent fossils near Boston.

Am. Jour. Sci., 3d ser., vol. xliii, pp. 201–209.

960 —— Recent fossils of the harbor and back bay, Boston.

Boston Soc. Nat. Hist., Proc., vol. xxv, pp. 305–316.

Gives a table of 25 species of recent fossils found near Boston, 14 of which are distinctly southern and indicate that the sea here during a recent period has been warmer than at present. Since the post-Glacial oscillations are found to extend over all the North Atlantic region, the climatic changes are probably due to conditions determined by geographic movements of elevation and subsidence, with their effect on oceanic circulation.

V.

961 **Van Hise** (Charles Richard). The iron ores of the Lake Superior region.

Wis. Acad. Sci. Arts and Letters, vol. viii, pp. 219–227.

Abstract: Am. Nat., vol. xxvi, pp. 938–939.

Describes the geologic relations of the two formations with which the ore deposits are associated and discusses the question of the genesis of the ores.

962 **Van Hise** (Charles Richard). Correlation papers, Archean and Algonkian.

U. S. Geol. Surv., Bull. No. 86, pp. 549, pls. i–xii.

Review: Jour. of Geol., vol. i, pp. 525–531.

Gives a description of the Archean and Algonkian sections in the United States and Canada, and reviews the literature concerning their classification and correlation. Includes a discussion on the succession of these formations, the principles of correlation, and references to the literature.

963 —— The relations of the Archean and the Algonkian in the Northwest.

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xl, p. 260.

Reviews some opinions concerning the relations of the Archean and Algonkian. States that the upper series of the Huronian rests unconformably on the Archean and in the Marquette and Menominee districts the Lower Huronian rests unconformably on the Basement Complex.

964 —— The iron ores of the Marquette district of Michigan.

Am. Jour. Sci., 3d ser., vol. xliii, pp. 116–132.

Abstract: Eng. and Min. Jour., vol. liv, p. 29.

Describes the manner of occurrence of the iron ores of this district, with incidental mention of those of the Menominee and Vermillion Lake districts. Concludes that the local concentration into workable bodies began in Upper Huronian time or later, and may be still going on; that the genesis of Upper and Lower Huronian ores is alike, and the principle of secondary concentration by downward percolating waters is generally applicable to Lake Superior deposits.

965 —— An historical sketch of the Lake Superior region to Cambrian time.

Jour. of Geol., vol. i, pp. 113–128.

Describes the lithologic characters of the Basement Complex, the Huronian, the Keweenawan and Lake Superior sandstone in this region, and the movements of elevation and subsidence that characterized each epoch. Accompanied by colored geologic map.

966 —— Summary of current pre-Cambrian North American literature.

Jour. of Geol., vol. i, pp. 304–314 and 532–541.

Reviews the current literature on the North American pre-Cambrian.

967 —— Some dynamic phenomena shown by the Baraboo quartzite ranges of central Wisconsin.

Jour. of Geol., vol. i, pp. 347–355.

Describes the dynamic phenomena and the changes which the quartzite has undergone in passing from a massive quartzite, showing little evidence of movement, to rocks that have been fractured and cleaved, and finally to a rock that is apparently a crystalline schist.

968 —— The Huronian volcanics south of Lake Superior.

Abstract: Geol. Soc. Am., Bull., vol. iv, pp. 435–436.

969 —— **Irving** (R. D.) and. Penokee iron-bearing series.

U. S. Geol. Surv., 10th Ann. Rept., pp. 341–507.

Abstract: Am. Geol., vol. ix, pp. 207–208.

Noticed in Record for 1891.

969*a* **Van Hise** (C. H.), **Irving** (R. D.) and. The iron-bearing series of Michigan and Wisconsin.

See Irving (R. D.) and Van Hise (C. R.), 489.

969*b* —— **Pumpelly** (R.) and. Observations upon the structural relations of the Upper Huronian, Lower Huronian, and Basement Complex on the north shore of Lake Huron.

See Pumpelly (R.) and Van Hise (C. R.), 768.

970 **Vogdes** (Anthony W.). On the North American species of the genus Agnostus.

Am. Geol., vol. ix, pp. 377–396.

Reviews the literature of the subject and describes many different species.

971 —— On the genus Amphyx, with descriptions of American species.

Am. Geol., vol. xi, pp. 99–109.

Gives a historical sketch of this genus, with plates and descriptions of American species.

972 —— On some new Sedalia trilobites.

St. Louis Acad. Sci., Trans., vol. v, pp. 615–618.

Describes a new species from the Sedalia limestone and discusses the classification of Sedalia Crustacea and the age of the limestone.

973 —— A classed and annotated bibliography of the Paleozoic Crustacea, 1698–1892.

Cal. Acad. Sci., Occasional Papers iv, pp. 1–412.

Contains a bibliography of Paleozoic Crustacea and a catalogue of North American species.

W.

974 **Wachsmuth** (Charles) and **Springer** (F.) Description of two new genera and eight species of camerate crinoids from the Niagara group.

Am. Geol., vol., x, pp. 135–144.

Describes the different species and gives their horizon and locality.

975 **Wadsworth** (M. E.). Subdivisions of the Azoic Archean in northern Michigan.

Science, vol. xx, p. 355; Am. Jour. Sci., 3d ser., vol. xlv, pp. 72–73 (½ p.) (correspondence).

Gives the subdivisions in tabular form.

976 **Wahnschaffe** (Felix). Mittheilungen über das Glacialgebiet Nordamerikas. I. Die Endmoränen von Wisconsin und Pennsylvania.

Zeit. Deut. Geol. Gesell., Band xliv, Heft 1, pp. 107–122.

Describes the drift and terminal moraines in Wisconsin and Pennsylvania. Considers the terminal moraine does not mark the southern limit of glaciation. Compares the terminal moraines of Europe and North America.

977 **Walcott** (Charles Doolittle). Note on Lower Cambrian fossils from Cohasset, Mass.

Wash. Biol. Soc., Proc., vol. vii, p. 155.

Mentions two Cambrian fossils found at Cohasset which are identical with species found in Newfoundland.

978 **Walcott** (Charles Doolittle). Notes on the Cambrian rocks of Virginia and the southern Appalachians.

Am. Jour. Sci., 3d ser., vol. xliv, pp. 52–57.

Describes localities in the southern Appalachian region in which Cambrian fossils have been found and compares the strata with those at different points in the northern United States and in Canada.

979 —— Notes on the Cambrian rocks of Pennsylvania and Maryland, from the Susquehanna to the Potomac.

Am. Jour. Sci., 3d ser., vol. xliv, pp. 469–482.

Describes the formations of the region and gives two vertical sections, with list of fossils found in each bed. Reviews the opinions of other writers on the structure of the Blue Ridge. Considers the Balcony Falls section the key to the succession of sedimentary strata of Maryland and Pennsylvania, and that the "great thicknesses" which are said to occur in South Mountain are the result of foldings and overthrust faultings of the Cambrian and pre-Cambrian strata.

980 —— Preliminary notes on the discovery of a vertebrate fauna in Silurian (Ordovician) strata.

Geol. Soc. Am., Bull., vol. iii, pp. 153–167, 3 pls.; discussion, pp. 168–171.

Abstract: Am. Nat., vol. xxvii, pp. 268–269 (½ p.).

Describes the locality, near Canyon City, Colo., in which the fossils were found, gives the vertical section, and names the fossils found in the different beds. The vertical range of the fossils is 75 or 80 feet of the Harding quarry section, which extends horizontally 8 miles. The evidence of the existence of vertebrates is confined to plates and scales of ganoid fishes and a chordal sheath of a fish allied to Chimæra.

981 —— Systematic list of fossils found at Eureka, Nev.

U. S. Geol. Surv., Monograph XX, Appendix A, pp. 319–333.

Includes a list of fossils of each geologic horizon represented in this district.

982 —— The North American continent during Cambrian time.

U. S. Geol. Surv., 12th Ann. Rept., part i, pp. 529–568, pls. xlii-xlv.

Abstracts: Am. Nat., vol. xxvii, pp. 734–735; Am. Jour. Sci., 3d ser., vol. xlv, p. 163 (6 l.).

Describes the character and extent of Cambrian sediments. Gives a description of the geographic distribution of pre-Cambrian land, and discusses the continental features and the relations of land and sea during middle- and post-Cambrian times.

983 —— Correlation Papers. Cambrian.

U. S. Geol. Surv., Bull. No. 81.

Abstract: Am. Geol., vol. ix, pp. 203–205; Am. Jour. Sci., 3d ser., vol. xliii, p. 244 (¼ p.).

Noticed in Record for 1891.

984 —— The Natural Bridge of Virginia.

Nat. Geog. Mag., vol. v, pp. 59–62.

Gives a diagrammatic section of the rocks cut by the canyon and describes the geologic formation and structure at this locality.

985 —— The geologist at Blue Mountain, Maryland.

Nat. Geog. Mag., vol. v, pp. 84–88; Sci. Amer. Suppl., vol. xxxvi, pp. 14753–14754.

Describes the geologic formations and their structure in this region. Gives a general sketch of the geologic history of the Blue Ridge.

986 **Walcott** (Charles Doolittle). Geologic time as indicated by the sedimentary rocks of North America.

Jour. of Geol., vol. i, pp. 639–676; Am. Geol., vol. xii, pp. 343–368.

Gives the estimates of different authors of the duration of geologic time. Describes the continental growth during the various geologic ages, the geographic conditions limiting the extent of Paleozoic sediments in the Cordilleras, the source and character of the material, and the conditions under which they were accumulated, with a discussion of the various processes of deposition and an estimate of the length of Paleozoic time in this region. Gives the ratios of the geologic periods adopted by other writers and presents the author's summary of the duration of each geologic period.

987 **Walther** (Johannes). The North American deserts.

Nat. Geog. Mag., vol. iv, pp. 163–176.

Describes the "Bad Lands" of Dakota, the region about Great Salt Lake and that of the Mohave Desert, and compares them with the deserts of northern Africa. Discusses the causes of erosion in the canyon of the Colorado.

988 —— A comparison of the deserts of North America with those of North Africa and northern India.

Science, vol. xix, p. 158.

Gives an abstract of paper read before the Geographical Society of Berlin.

989 **Wanner** (A.). Fossil tracks in the Trias of York County, Pa.

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xl, p. 286 (5 l.).

990 **Ward** (Lester F.). Principles and methods of geologic correlation by means of fossil plants.

Am. Geol., vol. ix, pp. 34–47.

Abstracts: Am. Assoc. Adv. Sci., Proc., vol. xl, pp. 288–289; Am. Nat., vol. xxvi, p. 243 (½ p.).

Discusses the theory of homotaxis and gives the principles and methods which should govern the study of paleobotany as an aid to geologic correlation.

991 —— The plant-bearing deposits of the American Trias.

Geol. Soc. Am., Bull., vol. iii, pp. 23–31.

Abstracts: Am. Assoc. Adv. Sci., Proc., vol. xl, pp. 286–288; Am. Jour. Sci., 3d ser., vol. xliii, p. 157 (½ p.).

Discusses the relations of the Trias beds with those which preceded and followed them. Divides the plant-bearing Trias into five geographic areas and in tabular form shows the number of species common to each area.

992 **Ward** (R. DeC.). Another river pirate.

Science, vol. xix, pp. 7–9.

Describes the process of uplift and erosion by which one stream has captured another in northeastern Pennsylvania.

993 **Ward** (Thomas). The salt deposits of the United States of America and Canada.

Manchester Geol. Soc., Trans., vol. xx, pp. 471–495.

Describes the salt beds in the States of New York, Michigan, and Kansas, and those of Canada.

994 **Warman** (Philip Creveling). Bibliography and index of the publications of the United States Gelogical Survey, with laws governing their printing and distribution.

U. S. Geol. Surv., Bull. No. 100, pp. 9–494.

Gives the title and table of contents of each publication of the Survey, the laws governing their printing and distribution, and an index.

995 **Watts** (W. L.). Alameda County [California].

Cal. State Min. Bur., 11th Rept., pp. 121–138.

Contains notes on an occurrence of manganese, quicksilver, building stones, and artesian wells.

996 —— Coal and clays in Amador County [California].

Cal. State Min. Bur., 11th Rept., pp. 146–149.

Notes on the occurrence of coal and clays in this county.

997 —— Colusa County [California].

Cal. State Min. Bur., 11th Rept., pp. 179–188.

Notes on the water supply, salt springs, quicksilver, gold, sulphur, and coal mines of the county.

998 —— Contra Costa County [California].

Cal. State Min. Bur., 11th Rept., pp. 189–194.

Notes on coal mines of Mount Diablo.

999 ——Del Norte County [California].

Cal. State Min. Bur., 11th Rept., pp. 195–199.

Includes brief notes on the placer, copper, and coal mines and building stones.

1000 —— Fresno County [California].

Cal. State Min. Bur., 11th Rept., pp. 210–218.

Describes the superficial formations of a portion of the county, with remarks on some coal mines.

1001 —— Humboldt County [California].

Cal. State Min. Bur., 11th Rept., pp. 227–232.

Gives notes on some of the coal seams and gold-bearing sands of the coast.

1002 —— Kern County [California].

Cal. State Min. Bur., 11th Rept., pp. 233–238.

Notes on the occurrence of sulphur and gypsum and artesian wells.

1003 —— Lake County [California].

Cal. State Min. Bur., 11th Rept., pp. 239–240.

Notes on some quicksilver mines.

1004 —— Marin County [California].

Cal. State Min. Bur., 11th Rept., pp. 249–254.

Brief notes on the occurrence of coal, silver, gold, copper, iron, and manganese.

1005 —— Sacramento County [California].

Cal. State Min. Bur., 11th Rept., pp. 334–336.

Notes on the occurrence of coal.

1006 —— Santa Clara County [California].

Cal. State Min. Bur., 11th Rept., pp. 374–375.

Brief notes on the occurrence of quicksilver, manganese, and magnesite.

1007 **Watts** (W. L.). Sonoma County [California].

Cal. State Min. Bur., 11th Rept., pp. 453–463.

Notes on some coal and quicksilver mines.

1008 —— Stanislaus County [California].

Cal. State Min. Bur., 11th Rept., pp. 464–468.

Notes on the Summit quicksiver mine.

1009 **Weed** (Walter Harvey). Two Montana coal fields.

Geol. Soc. Am., Bull., vol. iii, pp. 301–330.

Abstract: Am. Geol., vol. xi, pp. 181–182.

Describes the extent, structure, lithologic character, and the fauna of the Great Falls coal field. The coal occurs in the Kootenai formation. Describes the extent and location of the Rocky Fork coal field. The coal seams occur interbedded with coarse sandstones and thin clayey shales, which are considered to represent Fort Union beds.

1010 —— The coal fields of Montana.

Eng. and Min. Jour., vol. liii, pp. 520–522 and 542–543, and vol. lv, p. 197.

Describes the geologic occurrence of the coal beds and the character and extent of the coal seams in the Rocky Fork, Bozeman, Cinnabar, Gallatin, Judith, Great Falls, Sweet Grass Hills, and the Flathead Valley coal fields of Montana.

1011 —— The fossil forests of the Yellowstone.

School of Min. Quart., vol. xiii, pp. 230–236.

Describes the geologic structure of the region and states that the fossil trees are found in a series of breccias and tuffs and have been exposed by weathering of the rocks. These forests grew upon the flanks of a volcano and were covered and preserved by the débris of its eruptions.

1012 —— Geysers.

Smith. Inst., Ann. Rept., 1891, pp. 163–178.

Describes the occurrence of geysers in different parts of the world, discusses the theories of geyser action, and gives a summary of conclusions.

1013 —— The glaciation of the Yellowstone Valley north of the park.

U. S. Geol. Surv., Bull. No. 104, pp. 11–41, pls. i–iv.

Describes the character of certain peculiar marginal valleys in this region, illustrated by colored geologic map showing the distribution of the glacial deposits.

1014 —— The Laramie and the overlying Livingston formation in Montana.

U. S. Geol. Surv., Bull. No. 105, pp. 10–63, pls. i–vi.

Describes the Laramie strata and applies the name Livingston to beds of post-Laramie age largely composed of volcanic material. Defines the Fort Union formation and discusses the evidences of unconformity between the Laramie and Livingston formations and the age of the Livingston series.

1015 **Weeks** (Joseph D.). Manganese.

U. S. Geol. Surv., Min. Res., 1892, pp. 169–226.

Discusses the origin and occurrence of manganese ores. Describes the deposits of Georgia, Arkansas, and Crimora, Va., the latter illustrated by two figures. Discusses the character of these ores and gives many analyses and tables of production.

1016 **Wells** (David A.). Remarkable bowlders.

Pop. Sci. Monthly, vol. xl, pp. 340–346.

Gives size and weight of some bowlders found in Connecticut and Massachusetts.

1017 **Wells** (H. G.). The making of mountain chains.

Sci. Am. Suppl., vol. xxxvi, pp. 14974–14975.

Reviews the theories concerning the formation of mountain ranges.

1018 **Wells** (H. L.) and **Penfield** (S. L.). On herderite from Hebron, Me.

Am. Jour. Sci., 3d ser., vol. xliii, pp. 114–116.

Abstract: Am. Nat., vol. xxvii, p. 276 (¼ p.).

1019 **Westgate** (Lewis G.). The geographic development of the eastern part of the Mississippi drainage system.

Am. Geol., vol. xi, pp. 245–260.

Abstract: Jour. of Geol., vol. i, pp. 420–421.

Describes the post-Carboniferous drainage and its adjustment in different regions, the geographic and geologic features of the Cretaceous base-level and its elevation at the commencement of the Tertiary, and the character and extent of the Tertiary erosion.

1020 **White** (C. A.). On the Bear River formation, a series of strata hitherto known as the Bear River Laramie [Wyoming].

Am. Jour. Sci., 3d ser., vol. xliii, pp. 91–97.

Abstract: Am. Geol., vol. ix, pp. 266–267.

Reviews the publications of other writers regarding the age of the Bear River formation. His examinations, made in company with Mr. T. W. Stanton, whose article on the stratigraphic position of this formation immediately follows, led them to believe that the formation hitherto known as the Bear River Laramie is much older than it had hitherto been considered and that it underlies the equivalent of the Fort Benton Cretaceous.

1021 —— Correlation papers. Cretaceous.

U. S. Geol. Surv., Bull. No. 82.

Abstract: Am. Geol., vol. xii, pp. 398–399.

Noticed in Record for 1891.

1022 **White** (David). Flora of the outlying Carboniferous basins of southwestern Missouri.

U. S. Geol. Surv., Bull. No. 98, pp. 11–121, pls. i–v.

Gives the localities where specimens were found and a description of their manner of occurrence. Describes their general characteristics, habitat, and relations.

1023 —— A new tæniopteroid fern and its allies.

Geol. Soc. Am., Bull., vol. iv, pp. 119–132.

Abstracts: Jour. of Geol., vol. i, p. 419 (¼ p.); Am. Geol., vol. xi, p. 412 (7 l.); Am. Jour. Sci., 3d ser., vol. xlv, pp. 439–440 (½ p.).

Describes fossil plants from the Lower Coal Measures of the Carboniferous of Henry County, Mo.

1024 —— The Cretaceous at Gay Head, Marthas Vineyard.

Science, vol. xx, pp. 332–333.

Discusses the evidences of the age of certain beds in this vicinity.

1025 **White** (I. C.). The Mannington oil field and the history of its development. Appendix: The anticlinal theory of natural gas.

Geol Soc. Am., Bull., vol. iii, pp, 187–216.

Abstract: Am. Geol., vol. x, p. 65 (½ p.).

The oil is found in the Pocono sandstone, the lowest member of the Carboniferous, and it is known that this horizon contains hydrocarbons over a wide area. Three vertical sections are given and a historical sketch of the Mannington field and of the application of the "anticlinal theory." It is believed that the petroleum has been formed from the organic matter within the rock itself and that by the tilting of the beds the water, gas, and oil have been rearranged according to their respective gravities under the existing artesian pressure.

1026 —— Fossil plants from the Wichita or Permian beds of Texas.

Geol. Soc. Am., Bull., vol. iii, pp. 217–218.

Gives a list of the fossil plants as determined by Prof. Wm. M. Fontaine. From a comparison of these plants with those found in the beds above the Waynesburg coal horizon of West Virginia, and the general stratigraphic relations, it follows that the beds known as the Dunkard Creek series are of Permian age.

1027 —— Stratigraphy of the bituminous coal field of Pennsylvania, Ohio, and West Virginia.

U. S. Geol. Surv., Bull. No. 65.

Abstracts: Am. Jour. Sci., 3d ser., vol. xliii, p. 156 (½ p.); Am. Geol., vol. ix, p. 264 (⅓ p.).

Noticed in Record for 1891.

1028 **Whiteaves** (J. F.). Description of a new genus and species of Phyllocarid Crustacea from the Middle Cambrian of Mount Stephens, British Columbia.

Can. Rec. Sci., vol. v, pp. 207–208.

Describes Anomalocaris (n. gen.), the locality where found, and the associated fauna.

1029 —— Notes on the Gasteropoda of the Trenton limestone of Manitoba, with a description of one new species.

Can. Rec. Sci., vol. v, pp. 317–328.

Describes the lithologic character of the Trenton limestone of Manitoba, with notes on the fossils found in it.

1030 —— Descriptions of two new species of Ammonites from the Cretaceous rocks of the Queen Charlotte Islands.

Can. Rec. Sci., vol. v, pp. 441–446.

Describes and figures Olcostephanus (Astieria) deansii (n. sp.) and Hoplites haidaquensis (n. sp.).

1031 —— The Orthoceratidæ of the Trenton limestone of the Winnipeg basin.

Can. Roy. Soc., Proc. and Trans., vol. ix, sect. iv, pp. 77–90.

Abstract: Am. Geol., vol. x, p. 124.

1032 **Whiteaves** (J. F.). Notes on the Ammonites of the Cretaceous rocks of the district of Athabasca, with description of four new species.

Can. Roy. Soc., Proc. and Trans., vol. x, sect. iv, pp. 111–121, pls. viii–xi.

Gives a section of the rocks in the region of the Athabasca and Lesser Slave rivers and describes some fossils found in these localities.

1033 —— The Cretaceous system of Canada.

Can. Roy. Soc., Proc. and Trans., vol. xi, sect. iv, pp. 3–19.

Gives an account of the species found in the Cretaceous of British America, and reviews the literature treating of the Cretaceous system of North America.

1034 —— Note on the recent discovery of large Unio-like shells in the Coal Measures at the South Joggins, Nova Scotia.

Can. Roy. Soc., Proc. and Trans., vol. xi, sect. iv, pp. 21–24.

Gives the views of the latest authorities on the occurrence of the genus Unio and describes and figures Asthenodonta westoni (n. sp.).

1035 —— The fossils of the Devonian rocks of the islands, shores, or immediate vicinity of Lakes Manitoba and Winnipegosis.

Can. Geol. Surv., Cont. to Paleontology, vol. i, part iv, pp. 255–359, pls. xxxiii–xlvii.

Abstracts: Am. Nat., vol. xxvii, pp. 469–470 (½ p.); Am. Jour. Sci., 3d ser., vol. xliv, p. 429 (½ p.).

Refers to the previous work done in this region and describes the characters of the fossils collected.

1036 **Whitfield** (Robert P.). Gasteropoda and Cephalopoda of the Raritan clays and greensand marls of New Jersey.

U. S. Geol. Surv., Monograph XVIII, pp. 402, pls. i–l, figs. 1–2.

Abstracts: Am. Geol., vol. xii, pp. 329–330; Am. Nat., vol. xxvii, pp. 728–729.

Contains tables showing the genera and species and their distribution in the several beds of New Jersey; also in other States, and description of species.

1037 —— Republication of descriptions of Lower Carboniferous Crinoidea from the Hall collection now in the American Museum of Natural History, with illustrations of the original type specimens not heretofore figured.

Am. Mus. Nat. Hist., Mem., vol. i, part i, pp. 1–37, pls. i–iii.

Quotes the descriptions of each species by Prof. James Hall, with comments.

1038 —— Discovery of a second example of the Macrouran decapod crustacean, Palæopalæomon newberryi.

Am. Geol., vol. ix, pp. 227–238.

Describes the specimen which is said to have been found in the Kinderhook group near Burlington, Iowa.

1039 **Whittle** (Charles Livy). An ottrelite-bearing phase of a metamorphic conglomerate in the Green Mountains.

Am. Jour. Sci., 3d ser., vol. xliv, pp. 270–277.

Abstract: Am. Nat., vol. xxvii, p. 382 (½ p.).

Describes the occurrence and physical and microscopic characters of the ottrelite schist.

1040 **Whittle** (Charles Livy). Some dynamic and metasomatic phenomena in a metamorphic conglomerate in the Green Mountains.

Geol. Soc. Am., Bull., vol. iv, pp. 147–166.

Abstract: Am. Geol., vol. xi, p. 412 (½ p.).

Describes the character and extent of the ottrelite schist in the conglomerate and its alteration products and the petrographic characters of the rock. Describes the occurrence of clastic material in the conglomerate, the secondary enlargement of clastic tourmalines, the alteration of the feldspars, and the occurrence of albites.

1041 **Williams** (Albert, Jr.). Why dip is more likely to be regular than strike with fissure veins.

Eng. and Min. Jour., vol. liii, p. 398.

The fact that veins are usually on the lines of fault fissures is considered the principal reason why dip is more regular than strike.

1042 **Williams** (Edward H., Jr.). Glaciation in Pennsylvania.

Science, vol. xxi, p. 343.

Abstract: Am. Geol., vol. xii, p. 166 (¼ p.).

Gives some of the results of a study of the glacial phenomena in the vicinity of South Bethlehem.

1043 **Williams** (George Huntington). The volcanic rocks of South Mountain, in Pennsylvania and Maryland.

Am. Jour. Sci., 3d ser., vol. xliv, pp. 482–496; Sci. Amer. Suppl., vol. xxxv, pp. 14208–14209.

Abstracts: Am. Geol., vol. xi, pp. 55–56; Johns Hopkins Univ. Circ., vol. xii, pp. 45–47.

Quotes the opinions of other writers assigning a sedimentary origin to the rocks of South Mountain. States that these rocks have preserved all the essential characteristics of recent rhyolites and basalts. Describes their petrographic characters and gives analyses of several varieties.

1044 —— Piedmontite and scheelite from the ancient rhyolite of South Mountain, Pennsylvania.

Am. Jour. Sci., 3d ser., vol. xlvi, pp. 50–57.

Describes the microscopic characteristics of these minerals and the occurrence of piedmontite as a microscopic constituent of rhyolite. Gives two chemical analyses and a list of the recorded occurrences of piedmontite as a rock constituent.

1045 —— On the use of the terms poikilitic and micro-poikilitic in petrography.

Jour. of Geol., vol. i, pp. 176–179.

Describes various occurrences of this structure and suggests the use of the terms in petrographic descriptions.

1046 —— Notes on the microscopical character of rocks from the Sudbury mining district, Canada.

Can. Geol. Surv., Reports, vol. v, new series, 1890–91, part i, Report F, appendix 1, pp. 55–82.

The suite of rocks upon which this examination was based consists mainly of clastic rocks derived from granitic or gneissic débris and eruptives contemporaneous or subsequent in origin to the former. Both have been subjected to metamorphism and recrystallization. Describes the microscopic characters of greywacke, granite, gabbro, diorite, felsite, biotite-epidote gneiss, horneblende-biotite gneiss, sericitic-chlorite schist, vitrophyre tuff, and other rock varieties.

1047 **Williams** (George Huntington). Notes on some eruptive rocks from Alaska.

Nat. Geog. Mag., vol. iv, pp. 63–74.

Describes the petrographic characters of diorite, gabbro, micropegmatite, quartz-porphyry, hornblende-porphyrite, augite-porphyrite, and diabase,and states that these rocks bear a strong resemblance to the rocks which have come from portions of the Cordilleras and Great Basin farther southward.

1048 —— [Geology of Maryland.]

Maryland: Its Resources, Industries, and Institutions, Baltimore, 1893, pp. 55–58.

Abstract: Am. Geol., vol. xii, pp. 396–398.

Includes a general description of the various geologic formations of Maryland.

1049 —— and **Clark** (W. B.). Reports on short excursions made by the geological department of the university during the autumn of 1891.

Johns Hopkins Univ. Circ., vol. xi, pp. 37–39.

Describes the characters of the Coastal Plain deposits, their line of contact with the crystalline rocks and the rocks of the Piedmont plateau as seen in the sections examined.

1050 **Williams** (Henry Slater). The making of the geological time-scale.

Jour. of Geol., vol. i, pp. 180–197.

Reviews the classification of the geologic epochs adopted by different authors.

1051 —— The elements of the geological time-scale.

Jour. of Geol., vol. i, pp. 283–295.

Describes the geologic events which marked the periods that are represented in geologic classification and reviews the different estimates of the duration of geologic time.

1052 —— On the ventral plates of the carapace of the genus Holonema of Newberry.

Am. Jour. Sci., 3d ser., vol. xlvi, pp. 285–288.

Refers to previous descriptions of these plates and describes and figures their restoration from a specimen found in the Oneonta sandstone of New York.

1053 —— The scope of paleontology and its value to geologists.

Am. Geol., vol. x, pp. 148–169; Am. Assoc. Adv. Sci., Proc., vol. xli, pp. 149–170.

Reviews the history of the development of paleontology and the application of its principles by various writers in correlating the strata of different regions. The morphological characters exhibited by fossils indicate their ancestry and the conditions of their environment, and thus they become of paramount importance in investigations which pertain to the order of sequence of strata or to time-intervals.

1054 **Willimott** (C. W.). Canadian gems and precious stones.

Ottawa Nat., vol. v, pp. 117–142.

Gives a description of precious stones and the locality of their occurrence in Canada.

1055 **Willis** (Bailey). Studies in structural geology: The mechanics of Appalachian structure.

Am. Inst. Min. Engrs., Trans., vol. xxi, pp. 551–566.

U. S. Geol. Surv., 13th Ann. Rept., part ii, pp. 217–281, pls. xlvi–xcvi, figs. 16–17.

Abstracts: Jour. of Geol., vol. i, pp. 96–97; Eng. and Min. Jour., vol. liv, pp. 390–391.

Describes the structural features of the Appalachian region from Cambrian to Silurian time and discusses the conditions of folding and faulting. Gives an account of some experiments made to reproduce the forms of folding, illustrated by sketches. Gives the author's conclusions drawn from the experiments and discusses the different theories which have been advanced to explain the cause of Appalachian compression.

1056 —— Outlines of Appalachian history.

U. S. Geol. Surv., Geol. Atlas of the United States, Kingston, Chattanooga, and Ringgold sheets, Preliminary edition, 1892.

Describes the processes of sedimentary formation in the Appalachian province. Gives a general sketch of the Cambrian, Silurian, Devonian, Carboniferous, and post-Carboniferous epochs and a brief description of the mineral resources.

1057 —— Conditions of sedimentary deposition.

Jour. of Geol., vol. i, pp. 476–520.

Classifies the processes of erosion, discusses the sequence of sediments, and classifies and describes the processes of sedimentation and organic deposition.

1058 —— and **Hayes** (C. W.). Conditions of Appalachian faulting.

Am. Jour. Sci., 3d ser., vol. xlvi, pp. 257–268.

Abstract: Jour. of Geol., vol i, p. 861.

Describes the conditions of sedimentation prior to the development of Appalachian structure and the conditions under which step-folds and thrust faults and repeated parallel folds or faults were developed. Compares the theoretical conclusions with the observed Appalachian structure and discusses the evidence indicating the direction from which the compressive force acted.

1059 **Williston** (S. W.). The Niobrara Cretaceous of western Kansas.

Kans. Acad. Sci., Trans., vol. xiii, pp. 107–111, 2 pls.

Gives a history of the early explorations in this region. Describes many exposures assigned to the Cretaceous and discusses the evidences which indicate their geologic age.

1060 **Wills** (J. Lainson). On natural phosphates.

Ottawa Nat., vol. vi, pp. 7–22.

Gives in tabular form the approximate geologic age of the different phosphate deposits, the chemical analyses of some phosphatic materials and a classification of natural phosphates, and describes deposits occurring in different countries.

1061 —— [The phosphate mines of Canada.]

Am. Inst. Min. Engrs., Trans., vol. xxi, pp. 1000–1002.

In discussion of paper by H. B. Small.

1062 **Wilson** (E. B.). [Faulting in veins.]

Eng. and Min. Jour., vol. liii, p. 638 (correspondence).

Describes occurrence of "slickensides" in certain mines.

1063 **Wiltsee** (E. A.). Some additional Sierra County mines [California].

Cal. State Min. Bur., 11th Rept., pp. 413–419.

Notes on some gold mines.

1063*a* —— **Hobson** (J. B.) and. Nevada County [California].

See Hobson (J. B.) and Wiltsee (E. A.), 460.

1064 **Wiltsee** (Ernest). Notes on the geology of the Half-Moon Mine, Pioche, Nev.

Am. Inst. Min. Engrs., Trans., vol. xxi, pp. 867–873.

Abstract: Eng. and Min. Jour., vol. lv, p. 175.

Describes the geologic occurrence of the ore and the vein structure in this mine.

1065 **Winchell** (Horace V.). The Mesabi iron range.

Am. Inst. Min. Engrs., Trans., vol. xxi, pp. 644–686; Minn. Geol. and Nat. Hist. Surv., 20th Ann. Rept., pp. 111–180.

Abstracts: Am. Geol., vol. xi, pp. 355–356; Eng. and Min. Jour., vol. lv., pp. 177–178.

Describes the geology of the Mesabi Range, the stratigraphic relations of the Taconic and Archean rocks and the occurrence and quality of the ore and its varieties, and discusses the question of its origin.

1066 —— Note on Cretaceous in northern Minnesota.

Am. Geol., vol. xii, pp. 220–223.

Gives a list of fossils, determined by Dr. C. A. White to be of Cretaceous age, found in northern Minnesota. Describes other localities in which Cretaceous strata occur.

1067 —— and **Jones** (J. T.). The Biwabik mine.

Am. Inst. Min. Engrs., Trans., vol. xxi, pp. 951–961.

Describes the character of the ore and the extent of developments in this mine, located in the Mesabi Range, Minnesota.

1067*a* —— **Winchell** (N. H.) and. The iron ores of Minnesota.

See Winchell (N. H.) and Winchell (H. V.), 1080.

1068 **Winchell** (N. H.). The crystalline rocks.

Minn. Geol. and Nat. Hist. Surv., 20th Ann. Rept., pp. 1–28.

Gives a list of the principal rock formations of the Minnesota Lake Superior region and discusses the general principles of original and acquired rock structure, the character of the greenstones and schists, and the origin of crystalline rocks.

1069 —— Field notes of N. H. Winchell in 1890.

Minn. Geol. and Nat. Hist., 20th Ann. Rept., pp. 29–34.

Gives notes on some rock exposures in northeastern Minnesota.

1070 —— Oxide of manganese.

Minn. Geol. and Nat. Hist. Surv., 20th Ann. Rept., pp. 321–322.

Contains brief note, with chemical analysis, of an occurrence of manganese found in Wright County, Minn.

1071 —— The iron-bearing formations of northeastern Minnesota.

Abstract: Minn. Acad. Nat. Sci., Bull., vol. iii, pp. 168–169.

Brief description of the geologic formations of the region.

1072 **Winchell** (N. H.). The so-called Huronian rocks in the vicinity of Sudbury, Ontario.

Abstract: Minn. Acad. Nat. Sci., Bull., vol. iii, pp. 183–185.

Gives a summary of observations in this region and concludes that the Huronian, as defined by Canadian geologists, embraces two or three formations—the true Huronian, the Keewatin, and Vermillion series.

1073 —— The iron-bearing rocks of Minnesota.

Abstract: Minn. Acad. Nat. Sci., Bull., vol. iii, pp. 277–280.

Gives a brief description of the formations in which iron ore occurs and of the manner of its deposition.

1074 —— Frondescent hematite.

Am. Geol., vol. xi, pp. 20–21.

Refers to description of similar phenomena by W. S. Gresley in Am. Geol., April, 1892, and discusses the cause of certain channels which maintain their form and direction through the mass of the material.

1075 —— The Norian of the Northwest.

Minn. Geol. and Nat. Hist. Surv., Bull. No. 8, pp. iii–xxxiv.

Abstract: Am. Geol., vol xii, p. 60.

Gives an account of the investigation of the gabbros of the northern coast of Lake Superior, reviews the literature on the geology of this region, and describes the character and extent of gabbro rocks.

1076 —— The Kawishiwin agglomerate of Ely, Minn.

Am. Geol., vol. ix, pp. 359–368.

This agglomerate is the northern representative of the Lake Superior greenstones and is assigned to the Keewatin division of the Archean. Describes its peculiar characteristics at Ely and considers it originated from the joint action of oceanic water and igneous action.

1077 —— An approximate interglacial chronometer.

Am. Geol., vol. x, pp. 69–80.

Explains the evidences which indicate that the ancient Mississippi River once occupied a wider and deeper valley in Minnesota, and that it was choked up and expelled from its course by the movement of ice from the northeast on the initiation of the Glacial period. That during the interglacial period the river cut out a gorge, from which the author estimates the time-interval between the recession of the ice and its second invasion.

1078 —— Some problems of the Mesabi iron ore.

Am. Geol., vol. x, pp. 169–179.

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xli, p. 176 (7 l.).

Describes briefly the different hypotheses concerning the origin of iron ores, the character of the Mesabi iron ores and the stratigraphic relations of the inclosing rocks, and concludes that oceanic sedimentation is the only agent sufficient to explain the geographic and stratigraphic distribution of these deposits.

1079 —— Classification of the theories of the origin of iron ores.

Am. Geol., vol. x, pp. 277–278.

Gives in tabular form the theories advanced concerning the origin of iron ores.

1080 **Winchell** (N. H.) and **Winchell** (H. V.). The iron ores of Minnesota.

Minn. Geol. and Nat. Hist. Surv., Bull. No. 6, pp. 1–429, geologic map, 26 figures and 44 plates.

Includes a review of earlier Minnesota reports and describes the megascopic and microscopic characters of the Vermillion schists and the qualities and origin of their contained magnetites, those of the Keewatin schists and their hematites, and the character of the inclosing rocks of the Taconic (Animikie) ores and their origin, and includes a brief description of the Cretaceous limonites and of the various mines and explorations in each of these formations. Classifies and discusses the different theories on the origin of iron ores, with a bibliography of the subject and concluding observations. Appendix A is a discussion of a possible chemical origin of the Keewatin ores. Appendix B compares the Taconic ores of Minnesota and western New England. Appendix C discusses the eastern equivalents of the iron ores of Minnesota.

1081 —— and **Schuchert** (C.). Preliminary descriptions of new Brachiopoda from the Trenton and Hudson River groups of Minnesota.

Am. Geol., vol. ix, pp. 284–294.

Abstract: Am. Geol., vol. xii, p. 332 (½ p.).

Describes different species and mentions the formation and locality where found.

1082 **Winslow** (Arthur). An illustration of the flexibility of limestone.

Am. Jour. Sci., 3d ser., vol. xliii, pp. 133–134.

Describes and illustrates by sketch the flexibility of a slab of limestone.

1083 —— Notes on the Cambrian in Missouri and the classification of the Ozark series.

Am. Jour. Sci., 3d ser., vol. xlv, pp. 221–226.

Describes the earlier work in this region and the classification then adopted. Gives a résumé of the results attained by the present State Geological Survey of Missouri, accompanied by two cross-sections and a statement of what is considered to be the geologic succession.

1084 —— The Osage River and its meanders.

Science, vol. xxii, pp. 31–32.

Discusses the hypothesis of a former base-leveled condition to explain the sunken curved course of this river and suggests a different hypothesis.

1085 —— The mapping of Missouri.

St. Louis Acad. Sci., Trans., vol. vi, No. 3, pp. 57–99.

Abstract: Am. Geol., vol. x, p. 323 (⅜ p.).

Gives an account of the early explorations in the State and the maps published from the results of these explorations. Describes the work of mapping undertaken by the various State geological surveys of Missouri and the United States Geological Survey.

1086 **Winslow** (Arthur). The Missouri Coal Measures and the conditions of their deposition.

Geol. Soc. Am., Bull., vol. iii, pp. 109–121. Sketch map and seven sections.

Discusses the evidences which indicate the relations of the Lower Silurian and Carboniferous formations. The present marginal limits of the Coal Measures are near the original ones, since the marginal beds are distinctly marginal deposits and no Coal Measure strata occur far away from the general margin of the formation. Describes the rocks of the Coal Measure series and the conditions of their deposition.

1087 —— A preliminary report on the coal deposits of Missouri.

Mo. Geol. Surv., 1891, pp. 19–226, with 131 illustrations.

Abstracts: Am. Geol., vol. xi, pp. 271–273; Am. Jour. Sci., 3d ser., vol. xliii, p. 435 (¼ p.).

Describes the topographic and geologic features of the Coal Measure formation, the process of its deposition, the distribution and character of the contained coal beds and the conditions of the coal industry. Gives a description of the coal seams now worked in each county.

1088 —— The Higginsville sheet in Lafayette County [Missouri].

Mo. Geol. Surv., 1892, pp. 1–17.

Review: Am. Geol., vol. x, pp. 317–318.

Describes the topographic and hydrographic features of the area and the stratigraphy and structure of the formations represented, including sections showing the thicknesses and succession of coal seams and associated strata and a description of other mineral resources. Accompanied by a geologic and topographic map and a sheet of geologic sections.

1089 —— The Coal Measures of Missouri.

U. S. Geol. Surv., Min. Res., 1892, pp. 429–436.

The coal area forms a plateau of moderate elevation but slightly affected by erosion, and composed of horizontal strata of Carboniferous age. The measures are thickest near the margins, where they occur near the surface. The coals are all bituminous, except cannel coal, which is found in local and small deposits.

1090 —— Notes on the lead and zinc deposits of the Mississippi Valley and the origin of the ores.

Jour. of Geol., vol. i, pp. 612–619.

Gives a brief history of mining operations in this region. Reviews the literature and the theories advanced concerning the origin of these deposits.

1091 **Witter** (F. M.). Gas wells near Letts, Iowa.

Am. Geol., vol. ix, pp. 319–321.

Iowa Acad. Sci., Proc., vol. i, part ii, pp. 68–70.

States that gas was struck at a depth of 100 feet and that it probably comes from an accumulation of vegetable matter buried in the heavy drift deposit.

1092 **Wolff** (J. E.). The geology of the Crazy Mountains, Montana.

Geol. Soc. Am., Bull., vol. iii, pp. 445–452.

Abstracts: Am. Geol., vol. x, pp. 319-321; Am. Nat., vol. xxvi, pp. 1027–1028 (½ p.).

Describes the topographic features of the region. The range is made up of nearly horizontal Cretaceous rocks, consisting of sandstones and conglomerates, interstratified with shales and calcareous beds. Many laccolites occur which form the caps of monoclinal buttes developed on either side of the range. The eruptives occur in dikes, sheets, and laccolites, but no surface flows were observed.

1093 —— and **Tarr** (R. S.). Acmite-trachyte from the Crazy Mountains, Montana.

Harv. Mus. Comp. Zool., Bull., vol. xvi, pp. 227–233.

Abstract: Jour. of Geol., vol. i, pp. 637–638.

Describes the field occurrence and petrographic characters of some trachytic rocks from the Crazy Mountains.

1094 **Wood** (Herbert). Flathead coal basin, Montana.

Eng. and Min. Jour., vol. liv, p. 57.

Describes the topographic and geologic features of the region and the structural features of the coal seams.

1095 —— Mineral zones in Montana.

Eng. and Min. Jour., vol. liv, p. 292.

Describes some mineral zones of Montana and discusses their relation to the question as to the usual occurrence of certain mineral zones in certain geologic formations.

1096 —— Gold in placers.

Am. Geol., vol. ix, pp. 371–377.

States the general features of placer deposits and the manner of occurrence of gold in them. Gives a description of several Montana placers.

1097 —— A note on the Cretaceous of northwestern Montana.

Am. Jour. Sci., 3d ser., vol. xliv, pp. 401–406.

Describes the geologic formations of the region. The Cretaceous beds rest against the upturned edges of the Cambrian, consisting of about 7,500 feet of clays, shales, and sandstones. The coal of this district is lignitic.

1098 —— Glaciation in western Montana.

Science, vol. xx, p. 162.

Describes the general features of the country and the principal effects of its former glaciation.

1099 —— The Cabinet anticlinal.

Can. Rec. Sci., vol. v, pp. 261-266.

Describes the structure of a range of mountains on the borders of Idaho and Montana.

1100 **Woodward** (Arthur Smith). On the Lower Devonian fish fauna of Campbellton, New Brunswick.

Geol. Mag., dec. iii, vol. ix, pp. 1–6.

Abstract: Am. Geol., vol. ix, p. 263 (⅛ p.).

Describes some specimens recently collected in this locality.

1101 **Woodward** (Arthur Smith). Further contributions to knowledge of the Devonian fish fauna of Canada.

Geol. Mag., dec. iii, vol. ix, pp. 481–485.

Abstract: Am. Jour. Sci., 3d ser., vol. xlv, p. 73.

Describes some fish remains from the Upper Devonian of Quebec.

1102 **Woodworth** (J. B.). Note on the occurrence of erratic Cambrian fossils in the Neocene gravels of the island of Marthas Vineyard.

Am. Geol., vol. ix, pp. 243–247.

Describes the conglomerate bed in which the fossils were found and states that the pebbles were derived from a calcareous zone of the Olenellus Cambrian. Considers that there is an extensive Cambrian section in this region which is now concealed or has been removed by erosion.

1103 —— An attempt to estimate the thickness of the ice blocks which gave rise to lakelets and kettle-holes.

Am. Geol., vol. xii, pp. 279–284.

Refers to the occurrence of certain lakelets and ponds in Massachusetts and discusses the possibility of estimating the thickness of the ice that once filled them.

1104 **Woolman** (Lewis). Cretaceous ammonites and other fossils near Moorestown, N. J. Their stratigraphic position shown by an artesian-well section at Maple Shade, N. J. Incidental reference to water horizons.

Phil. Acad. Nat. Sci., Proc., 1893, part ii, pp. 219–224.

Describes the occurrence of some Cretaceous fossils from New Jersey.

1105 —— Artesian wells in southern New Jersey.

N. J. Geol. Surv., Ann. Rept. 1892, pp. 275–311.

Gives the sections displayed by numerous wells in this region, showing the thickness and character of the strata.

1106 **Wortman** (J. L.). On the divisions of the White River or Lower Miocene of Dakota.

Am. Mus. Nat. Hist., Bull., vol. v, pp. 95–105.

Describes the lithologic character of the Lower Miocene beds and their fauna, with a discussion of the distribution of the fauna and succession of types.

1107 —— and **Earle** (C.). Ancestors of the tapir from the Lower Miocene of Dakota.

Am. Mus. Nat. Hist., Bull., vol. v, pp. 159–180.

Discusses the origin of the tapir in America, describes species obtained from the Miocene of South Dakota, and reviews the evidence of the relationships between American and European species of Protapirus.

1108 —— **Osborn** (H. F.) and. Characters of Protoceras (Marsh), the new Artiodactyl from the Lower Miocene.

Am. Mus. Nat. Hist., Bull., vol. iv, pp. 351–371.

Abstracts: Am. Jour. Sci., 3d ser., vol. xlv, p. 160 (½ p.); Am. Nat., vol. xxvii, pp. 147–148.

Description of species and discussion of characters of species recently found.

1109 **Wortman** (J. L.)., **Osborn** (H. L.) and. Artionyx, a new genus of Ancyclopoda.

Am. Mus. Nat. Hist., Bull., vol. v, pp. 1–18.

Describes remains found in the Miocene of South Dakota.

1109*a* —— Fossil mammals of the Wasatch and Wind River beds.

See Osborn (H. L.) and Wortman (J. L.), 707.

1110 **Wright** (A. A.). Extra-morainic drift in New Jersey.

Am. Geol., vol. x, pp. 207–216.

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xli, p. 175 (⅓ p.).

Classifies the glacial deposits at various localities where extra-morainic materials occur. Accompanied by geologic sketch map.

1111 —— Older drift in the Delaware Valley.

Am. Geol., vol. xi, pp. 184–186.

Gives summary statements concerning the examination of Delaware Valley deposits which indicate the presence of older drift.

1112 **Wright** (G. Frederick). Supposed interglacial shell beds in Shropshire, England.

Geol. Soc. Am., Bull., vol. iii, pp. 505–508.

Describes the location and character of the shell beds. Considers they are not evidence of an interglacial subsidence, but that they were pushed along with other transported material by the glacier.

1113 —— The supposed post-Glacial outlet of the Great Lakes through Lake Nipissing and the Mattawa River.

Geol. Soc. Am., Bull., vol. iv, pp. 423–425.

Describes certain glacial phenomena indicating the temporary existence of another outlet to the Great Lakes in post-Glacial time.

1114 —— Additional evidence bearing upon the glacial history of the Upper Ohio Valley.

Am. Geol., vol. xi, pp. 195–199.

Discusses the evidences which indicate the pre-Glacial age of the Upper Ohio gorge, rather than interglacial.

1115 —— Theory of an interglacial submergence of England.

Am. Jour. Sci., 3d ser., vol. xliii, pp. 1–8.

Discusses the evidence in favor of an interglacial submergence of England afforded by marine shells on elevated positions. Favors the view that they have been raised by an advancing ice sheet from the sea-level to their present position. Instances phenomena of the Muir glacier in Alaska and the terminal moraines of Pennsylvania.

1116 —— Unity of the Glacial epoch.

Am. Sour. Sci., 3d ser., vol. xliv, pp. 351–373.

Reviews the opinions of other writers on the Glacial period. Gives the results of recent studies in New Jersey and Pennsylvania, accompanied by map of the region. Discusses the relations of the terraces of the Ohio River and its tributaries.

1117 —— Extra-morainic drift in the Susquehanna, Lehigh, and Delaware valleys.

Phila. Acad. Nat. Sci., Proc., 1892, part iii, pp. 469–484.

Quotes the opinions of various writers on glacial phenomena and gives the results of the author's recent observations in this region and the conclusions drawn therefrom.

1118 **Wright** (G. Frederick). Recent discoveries concerning the relation of the Glacial period in North America to the antiquity of man.

Brit. Assoc. Adv. Sci., Rept. 1891, pp. 647–649.

Incidentally refers to the tracing of the southern boundary of the glaciated region on the western continent and to the question of a succession of glacial epochs.

1119 **Wyatt** (Francis). The phosphates of Florida.

Eng. and Min. Jour., vol. liii, pp. 202–204.

Describes the topographic and geologic features of the State and the characteristics of the phosphate deposits. Discusses the question of their origin. This article taken from "Phosphates of America."

1120 —— [On the analysis of mineral phosphates].

Am. Inst. Min. Engrs., Trans., vol. xxi, pp. 172–174.

In discussion of paper by T. M. Chatard "Phosphate chemistry as it concerns the miner."

Y.

1121 **Yeates** (William S.). Plattnerite and its occurrence near Mullan, Idaho.

Am. Jour. Sci., 3d ser., vol. xliii, pp. 407–412.

Reviews previous descriptions of this mineral. Describes its mineral associates and gives a chemical analysis.

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Barycrinus
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Batocrinus
æquibrachiatus var. alatus, Whitfield, 1037.
agnatus n. sp., Miller, 670.
bisbrachiatus n. sp., Whitfield, 1037.
boonvillensis n. sp., Miller, 670.
cantonensis n. sp., Miller and Gurley, 673.
crawfordsvillensis n. sp., Miller, 670.
decorus n. sp., Miller, 670.
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facetus n. sp., Miller and Gurley, 673.
genista n. sp., Miller and Gurley, 673.
gorbyi n. sp., Miller, 670.
gurleyi n. sp., Miller, 670.
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jucundus n. sp., Miller and Gurley, 673.
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legrandensis n. sp., Miller and Gurley, 673.
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Bilobites Linné, Hall, 383.
Bittium
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chipolanum n. sp., Dall, 215.
var. burnsii Dall, Dall, 215.
cossmannii n. sp., Dall, 215.
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adamsi, Dall, 215.
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Bulla
conica n. sp., Whitfield, 1036.
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Bumelis? rhomboidea n. sp., Lesquereux, 582.
Cæcum
carolinianum n. sp., Dall, 215.
coronellum n. sp., Dall, 215.
floridanum Stimpson, Dall, 215.
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cineratius, Scudder, 823.
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Calceocrinus indianensis n. sp., Miller, 670.
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(erosum) n. sp., Dall, 215.
exile n. sp., Dall, 215.
grammaticum n. sp., Dall, 215.
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labrosum Conrad, Dall, 215.
metrium n. sp., Dall, 215.
nitens Lea, Dall, 215.
philanthropus Conrad, Dall, 215.
var. eliminatum Dall, Dall, 215.
(philanthropus var.?) conradianum Dall, Dall, 215.
virginicum Conrad, Dall, 215.
willcoxianum n. sp., Dall, 215.
(Eutrochus)
ceramicum n. sp., Dall, 215.
limulum n. sp., Dall, 215.
Callista
(Aphrodina?) tenuis H. and M., Stanton, 861.
(Dosiniopsis?) orbiculata H. and M., Stanton, 861.
Callistemophyllum heerii Ett., Lesquereux, 582.
Calyptraphorus velatus, Whitfield, 1036.
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Cancellaria
conradiana Dall, var. rotunda, Dall, 215.
malachitensis n. sp., Stanton, 861.
reticulata Linné, Dall, 215.
rudis n. sp., Whitfield, 1036.
(Merica) subalta, Whitfield, 1036.
(Trigonostoma) sericea n. sp., Dall, 215.
Candona
subreniformis n. sp., Jones, 506.
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Canimartes cumminsii Cope, Cope, 183.
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Carcharodon mortoni Gibbes, Lucas, 602.
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Cardinocrania Waagen, Hall, 383.
Cardiopsis tenuicostata n. sp., Whiteaves, 1035.
Cardium
pauperculum Meek, Stanton, 861.
trite White, Stanton, 861.
Caricella
plicata n. sp., Whitfield, 1036.
podagrina Dall, Dall, 215.
ponderosa n. sp., Whitfield, 1036.
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Carpites
coniger n. sp., Lesquereux, 582.
cordiformis n. sp., Lesquereux, 582.
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Carpolites, Dawson, 238.
Carpolithes (Zamites) meridionalis n. sp., Dawson, 239.
Carpolithus
harveyi n. sp., Fontaine, 328.
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Caryocrinus indianensis n. sp., Miller, 670.
Cassia
polita n. sp., Lesquereux, 582.
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Cassidaria carinata Lam.?, Whitfield, 1036.
Cassidulus
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florealis (Morton), Clark, 139.
micrococcus Gabb, Clark, 139.
porrectus Clark, Clark, 139.
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subconicus Clark, Clark, 139.
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Cassis (Phalium) globosum Dall, Dall, 215.
Castoroides ohioensis, Moore, 676.
Catobaris n. gen., Scudder, 823.
cœnosa, Scudder, 823.
Catopygus
oviformis Conrad, Clark, 139.
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Cavoscala n. gen, Whitfield, 1036.
annulata, Whitfield, 1036.
Celastrophyllum
crassipes n. sp., Lesquereux, 582.
cretaceum n. sp., Lesquereux, 582.
decurrens n. sp., Lesquereux, 582.
myrsinoides n. sp., Lesquereux, 582.
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obnuptus, Scudder, 823.
Centron n. gen., Scudder, 823.
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Cerithiopsis
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Cerithium
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callisoma n. p., Dall, 215.
caloosaense, Dall, 215.
chipolanum n. sp., Dall, 215.
coccodes n. sp., Dall, 215.
floridanum Morch, Dall, 215.
georgianum Lyell and Sowerby, Dall, 215.
glaphyrea n. sp., Dall, 215.
var. litharium, Dall, 215.
interlineatum n. sp., Cragin, 186.
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præcursor Heilprin, Dall, 215.
proctori n. sp., Cragin, 186.
tramitensis n. sp., Cragin, 186.
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Ceuthorhynchus
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compactus, Scudder, 823.
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Chara stantoni n. sp., Knowlton, 558.
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Chemnitzia coalvillensis Meek, Stanton, 861.
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Chiton (Trachyodon) eocenensis Conrad, Dall, 215.
Chonetella Waagen, Hall, 383.
Chonetes Fischer de Waldheim, Hall, 383.
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belli Billings, Sherzer, 836.
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Cimolodon
agilis n. sp., Marsh, 632.
parvus n. sp., Marsh, 632.
Cimolopteryx Marsh, Marsh, 635.
Cinnamomum
ellipsoideum Sap. & Mar., Lesquereux, 582.
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scheuchzeri Heer, Lesquereux, 582.
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sezannense Watelet, Lesquereux, 582.
Cinulia
ovoidea, Whitfield, 1036.
tarrantensis n. sp., Cragin, 186.
(Oligoptycha) naticoides, Whitfield, 1036.
Cissites
acerifolius n. sp., Lesquereux, 582.
alatus n. sp., Lesquereux, 582.
brownii Lesq., Lesquereux, 582.
dentato-lobatus n. sp., Lesquereux, 582.
formosus Heer, Lesquereux, 582.
ingens n. sp., Lesquereux, 582.
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obtusilobus n. sp., Lesquereux, 582.
populoides n. sp., Lesquereux, 582.
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Cleonus
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canadensis n. sp., Woodward, 1101.
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principalis, Scudder, 823.
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Cœliocrinus dilattaus, Whitfield, 1037.
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Collonia
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Coloceras n. gen., Hyatt, 478.
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Colodon
luxatus Marsh, 642.
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Columbella
(Anachis) Adams, Dall, 215.
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avara var. caloosaensis Dall, Dall, 215.
camax n. sp., Dall, 215.
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styliola n. sp., Dall, 215.
(Astyris) Adams, Dall, 215.
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alveolata, James, 491.
calicina, James, 491.
(?) halli, James, 491.
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Colutea primordialis Heer, Lesquereux, 582.
Coniatus
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Coniophis precedens n. gen. et sp., Marsh, 633.
Conocardium
elrodi n. sp., Miller, 670.
exiguum n. sp., Miller, 670.
indianense n. sp., Miller, 670.
parvulum n. sp., Miller, 670.
Conomitra staminea Conrad, Dall, 215.
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Conularia sampsoni n. sp., Miller, 670.
Conus
adversarius Conrad, Dall, 215.

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pealii Green, Dall, 215.
proteus Hwass, Dall, 215.
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subsaurideus, Whitfield, 1036.
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Coptosoma
mortoni (de Loriol), Clark, 139.
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Coralliophila
abbreviata Lamarck, Dall, 215.
lepidota n. sp., Dall, 215.
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Corbula
kanabensis n. sp., Stanton, 861.
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Cordaicarpus lineatus Lx., White, 1022.
Cordaites communis Lx., White, 1022.
Cordania, Clarke, 149.
Cornus
obesus n. sp., Dawson, 239.
platyphylloides n. sp., Lesquereux, 582.
præcox n. sp., Lesquereux, 582.
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Corvus annectens n. gen., Shufeldt, 837.
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obliquus Cope, Earle, 281.
radians, Cope, Earle, 281.
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Cossonus
gabbii, Scudder, 823.
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Crania
agaricina n. sp., Hall, 383.
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Craniella Œhlert, Hall, 383.
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Crassatella excavata n. sp., Stanton, 861.
Cratægus
aceroides n. sp., Lesquereux, 582.
lacœi n. sp., Lesquereux, 582.
laurenciana n. sp., Lesquereux, 582.
tenuinervis n. sp., Lesquereux, 582.
Cratoparis arcessitus, Scudder, 823.
Creccoides
osbornii Shufeldt, n. gen. et. sp., Cope, 182.
osbornii Schufeldt, Cope, 183.
Cremastorhynchus stabilis, Scudder, 823.
Creseis
corrugata n. sp., Matthew, 653.
minuta n. sp., Matthew, 653.
Crioceras annulatus, Shum., Cragin, 186.
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Cryptorhynchus
annosus, Scudder, 823.
durus, Scudder, 823.
kerri, Scudder, 823.
profusus, Scudder, 823.
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Ctenacanthus amblyxiphias n. sp., Cope, 170.
Ctenopyge acadica n. sp., Matthew, 654.
Cucullæa
comanchensis n. sp., Hill, 435.
gracilis n. sp., Cragin, 186.
gratioti Hill, Cragin, 186.
terminalis Con., Cragin, 186.
tippana Con., Cragin, 186.
transpecosensis n. sp., Cragin, 186.
Cuneamya sulcodorsata n. sp., Ulrich, 940.
Cyathocrinus
benedicti n. sp., Miller, 670.
gurleyi n. sp., Miller, 670.
labyrinthicus n. sp., Miller, 670.
opimus n. sp., Miller and Gurley, 673.
viminalis, Whitfield, 1037.
Cyathophycus siluriana n. sp., James, 491.
Cyathophyllum
petraioides n. sp., Whiteaves, 1035.
waskasense n. sp., Whiteaves, 1035.
Cycadeospermum
columnare n. sp., Lesquereux, 582.
lineatum n. sp., Lesquereux, 582.
rotundatum Font., Fontaine, 328.
Cycadites pungens n. sp., Lesquereux, 582.
Cyclocystoides cincinnatiensis n. sp., Miller and Faber, 672.
Cyclognathus rotundifrons Matt., Matthew, 653.
Cyclospira n. gen., Hall, 384.
Cyclospongia discus n. gen. et sp., Miller, 670.
Cyclostrema chipolanum n. sp., Dall, 215.
Cylichna recta, Whitfield, 1036.
Cylindrella floridana n. sp., Dall, 215.
Cylindrites formosus n. sp., Cragin, 186.
Cylindrœcelia, James, 491.
covingtonensis James, 491.
Cymba (Eucymba) Dall, Dall, 215.
Cyperites, Dawson, 238.
Cyphaspis bellula n. sp., Whiteaves, 1035.
Cyphosoma volanumn. sp., Cragin, 186.
Cypræa
heilprinii n. sp., Dall, 215.
pinguis Conrad, Dall, 215.
sabuloviridis n. sp., Whitfield, 1036.
willcoxi n. sp., Dall, 215.
(Aricia) mortoni, Whitfield, 1036.
(Siphocypræa) Heilprin, Dall, 215.
problematica Heilprin, Dall, 215.
Cypricardella
gorbyi n. sp., Miller, 670.
producta n. sp., Whiteaves, 1035.
Cypricardites
cingulata n. sp., Ulrich, 940.
germanus n. sp. or var., Ulrich, 940.
glabellus n. sp., Ulrich, 940.
haynianus?, Safford, Ulrich, 940.

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Cypricardites
modestus n. sp., Ulrich, 937.
nanus n. sp., Ulrich, 940.
obtusifrons n. sp., Ulrich, 940.
oviformis n. sp., Ulrich, 937.
sardesoni n. sp., Ulrich, 940.
tenellus n. sp., Ulrich, 940.
terminalis n. sp., Ulrich, 937.
Cypridea
texana n. sp., Hill, 435.
tuberculata var. wyomingensis nov., Jones, 506.
Cyprimeria
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excavata (Mort.), Cragin, 186.
gigantea n. sp., Cragin, 186.
texana, Roem., Cragin, 186.
Cyprina
mediale Con., Cragin, 186.
roemeri n. sp., Cragin, 186.
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Cypris purbeckinsis, Jones, 506.
Cyrena
æquilateralis Meek?, Stanton, 861.
inflexa Meek, Stanton, 861.
(Veloritina) securis Meek, Stanton, 861.
Cyrtia Dalman, Hall, 384.
burlingtonensis n. sp., Rowley, 790.
Cyrtoceras
indianense n. sp., Miller, 670.
luthei n. sp., Calvin, 112.
nashvillense n. sp., Miller, 670.
saffordi n. sp., Miller, 670.
(Glyptodendron) eatonense, Foerste, 324.
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canadensis n. sp., Whiteaves, 1032.
haidaquensis n. sp., Whiteaves, 1030.
mcconnelli n. sp., Whiteaves, 1032.
roemeri n. sp., Cragin, 186.
texanus n. sp., Cragin, 186.
Hormorus saxorum, Scudder, 823.
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Hydreionocrinus pentagonus n. sp., Miller and Gurley, 673.
Hydrobia
amnicoloides Pilsbry n. sp., Dall, 215.
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Hylobius
lacoei, Scudder, 823.
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Hymenæa dakotana n. sp., Lesquereux, 582.
Hyolithellus micans Billings, Matthew, 654.
Hyolithes
alatus n. sp., Whiteaves, 1035.
decipiens n. sp., Matthew, 654.
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Ichthyodectes
anaides Cope, Crook, 192.
polymicrodus Cope, Crook, 192.
Idiocrinus
elongatus W. and Sp. n. gen. et sp., Wachsmuth and Springer, 974.
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Iguanavus teres n. sp., Marsh, 633.
Ilex
armata n. sp., Lesquereux, 582.
borealis Heer, Lesquereux, 582.
dakotensis n. sp., Lesquereux, 582.
masoni n. sp., Lesquereux, 582.
papillosa n. sp., Lesquereux, 582.
scudderi n. sp., Lesquereux, 582.
Ilyanassa
granifera Conrad, Dall, 215.
irrorata Conrad, Dall, 215.
(porcina var.?) schizopyga, Dall, 215.
(Paranassa)
arata Say, Dall, 215.
isogramma n. sp., Dall, 215.
porcina Say, Dall, 215.
Incolaria securiformis n. gen. et sp., Herzer, 422.

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Inga cretacea n. sp., Lesquereux, 582.
Inocaulis, James, 491.
Inoceramus
cumminsi n. sp., Cragin, 186.
deformis Meek, Stanton, 861.
dimidius White, Stanton, 861.
exogyroides M. and H., Stanton, 861.
flaccidus White, Stanton, 861.
fragilis H. and M., Stanton, 861.
gilberti White, Stanton, 861.
labiatus Schlotheim, Stanton, 861.
multistriatus n. sp., Cragin, 186.
simsoni Meek, Stanton, 861.
tenuirostratus M. and H., Stanton, 861.
umbonatus M. and H., Stanton, 861.
undabundus M. and H., Stanton, 861.
Iphidea Billings, Hall, 383.
Ischnochiton tampænsis n. sp., Dall, 215.
Ischyrodonta ovalis n. sp., Ulrich, 940.
Isocardia humilis n. sp., Cragin, 186.
Isothea n. gen., Scudder 823.
alleni, Scudder, 823.
Juglandites
ellsworthianus n. sp., Lesquereux, 582.
fallax n. sp., Dawson, 239.
lacoei n. sp., Lesquereux, 582.
primordialis n. sp., Lesquereux, 582.
sinuatus n. sp., Lesquereux, 582.
Juglans
arctica Heer, Lesquereux, 582.
crassipes Heer, Lesquereux, 582.
Karpinskia Tschernyschew, Hall, 384.
Kayserella n. gen., Hall, 383.
Kayseria Davidson, Hall, 384.
Keyserlingia Pander, Hall, 383.
Koninckioceras, Hyatt, 478.
Kutorgina Billings, Hall, 383.
Laccopygus n. gen., Scudder, 823.
nilesii, Scudder, 823.
Lacertilia, Cope, 178.
Lachnopus
humatus, Scudder, 823.
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Laphmina Œhlert, Hall, 383.
Lapparia Conrad, Dall, 215.
Laricopsis longifolia Font., Fontaine, 328.
Larix churchbridgensis, Penhallow, 726.
Larus
californicus?, Shufeldt, 837.
oregonus n. sp., Shufeldt, 837.
philadelphia, Shufeldt, 837.
robustus n. sp., Shufeldt, 837.
Latirus
callimorphus n. sp., Dall, 215.
floridanus Heilprin, Dall, 215.
(floridanus var.?) multilineatus, Dall, 215.
hysipettus n. sp., Dall, 215.
rugatus n. sp., Dall, 215.
tessellatus n. sp , Dall, 215.
Laurelia primæva n. sp., Lesquereux, 582.
Laurophyllum
ellsworthianum Lesq., Lesquereux, 582.
insigne n. sp., Dawson, 239.

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Genera and species described—Continued.
Laurus
angusta Heer, Lesquereux, 582.
antecedens n. sp., Lesquereux, 582.
hollæ Heer, Lesquereux, 582.
knowltoni n. sp., Lesquereux, 582.
(Carpites)
microcarpa n. sp., Lesquereux, 582.
plutonia Heer, Lesquereux, 582.
teliformis n. sp., Lesquereux, 582.
Laxispira lumbricalis, Whitfield, 1036.
Lecanocrinus tennesseensis n. sp., Miller, 670.
Leda (?) harveyi n. sp., Hill, 435.
Leguminosites
constrictus n. sp., Lesquereux, 582.
convolutus n. sp., Lesquereux, 582.
coronilloides? Heer, Lesquereux, 582.
dakotensis n. sp., Lesquereux, 582.
hymenophyllus n. sp., Lesquereux, 582.
insularis Heer, Lesquereux, 582.
omphalobioides n. sp., Lesquereux, 582.
phæseolites? Heer, Lesquereux, 582.
podogonialis n. sp., Lesquereux, 582.
truncatus n. sp., Lesquereux, 582.
Leiocidaris
hemigranosa Shumard, Cragin, 186.
hemigranosus Shumard, Clark, 139.
Leiostraca cretacea, Whitfield, 1036.
Leperditia
æquilatera n. sp., Ulrich, 938.
fimbriata n. sp., Ulrich, 938.
germana n. sp., Ulrich, 938.
granilabiata n. sp., Ulrich, 938.
inflata n. sp., Ulrich, 938.
millepunctata n. sp., Ulrich, 938.
mundula n. sp., Ulrich, 938.
(?primitia) dorsicornis n. sp., Ulrich, 938.
sulcata n. sp. and ventricornis n. var., Ulrich, 938.
tumida n. sp., Ulrich, 938.
Lepiditta
auriculata n. sp., Matthew, 654.
sigillata n. sp., Matthew, 654.
Leptæna Dalman, Hall, 383.
charlottæ, Winchell and Schuchert, 1081.
Leptænisca Beecher, Hall, 383.
adnascens n. sp., Hall, 383.
tangens n. sp., Hall, 383.
Leptella n. gen., Hall, 383.
Leptobolus Hall, Hall, 383.
grandis n. sp., Matthew, 654.
Leptocœlia Hall, Hall, 384.
Leptomaria
gigantea n. sp., Whitfield, 1036.
pergranulosa n. sp., Whitfield, 1036.
perlata, Whitfield, 1036.
Leptomeryx, Scott, 818.
mammifer Cope, Ami, 18.
Leptoplastus spinosus n. sp., Matthew, 654.
Leptopora gorbyi n. sp., Miller, 670.
Leptopoterion, James, 491.
Leptostrobus longifolius, Dawson, 238.
Leuroceras, Hyatt, 478.

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bicornis n. sp., Ulrich, 939.
(Hoplolichas) robbinsi n. sp., Ulrich, 939.
(Terataspis) n. sp., Whiteaves, 1035.
Lima
generosa n. sp., Cragin, 186.
semilævis n. sp., Cragin, 186.
utahensis n. sp , Stanton, 861.
Limalophus n. gen., Scudder, 823.
compositus, Scudder, 823.
contractus, Scudder, 823.
Limnohyops
fontinalis, Earle, 282.
laticeps, Earle, 282.
Lindera
masoni n. sp., Lesquereux, 582.
venusta n. sp., Lesquereux, 582.
Lindstrœmella n. subgen., Hall, 383.
aspidium n. gen. et sp., Hall, 383.
Lingula Bruguiére, Hall, 383.
cf. billingsiana Whiteaves, Matthew, 654.
compta n. sp., Hall, 383.
flabellula n. sp., Hall, 383.
lingulata n. sp., Hall, 383.
paracletus n. sp., Hall, 383.
riciniformis var. galenensis, Winchell and Schuchert, 1081.
scutella n. sp., Hall, 383.
shumardi n. sp., Cragin, 186.
(Glossini) deflecta, Winchell and Schuchert, 1081.
Lingulasma Ulrich, Hall, 383.
galenensis, Winchell and Schuchert, 1081.
Lingulella Salter, Hall, 383.
cuneata n. sp., Matthew, 654.
Lingulepis Hall, Hall, 383.
Lingulops Hall, Hall, 383.
granti n. sp., Hall, 383.
Linnarssonia Walcott, Hall, 383.
Linthia tumidula Clark, Clark, 139.
Liochlamys bulbosa Heilprin, Dall, 215.
Liopeplum Dall, Dall, 215.
spillmani Dall, Dall, 215.
subjugosum Dall, Dall, 215.
Liopistha
(Psilomya)
concentrica n. sp., Stanton, 861.
elongata n. sp., Stanton, 861.
meeki White, Stanton, 861.
Lioplax floridana n. sp., Dall, 215.
Liotia
(Arene)
agenea n. sp., Dall, 215.
coronata n. sp., Dall, 215.
melium n. sp., Dall, 215.
paramata n. sp , Dall, 215.
solariella Heilprin, Dall, 215.
Liquidambar integrifolium Lesq., Lesquereux, 582.
Liriodendron
acuminatum Lesq., Lesquereux, 582.
acuminatum var. bilobatum n. var., Lesquereux, 582.

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Genera and species described—Continued.
Liriodendron
giganteum Lesq., Lesquereux, 582.
var. cruciforme Lesq., Lesquereux, 582.
intermedium Lesq., Lesquereux, 582.
meekii Heer, Lesquereux, 582.
obcordatum Lesq., Lesquereux, 582.
pinnatifidum Lesq., Lesquereux, 582.
prætulipiferum n. sp., Dawson, 239.
primævum Newb., Lesquereux, 582.
semialatum Lesq., Lesquereux, 582.
snowii n. sp., Lesquereux, 582.
succedens n. sp., Dawson, 239.
wellingtonii n. sp., Lesquereux, 582.
Lispoceras, Hyatt, 478.
rotundum n. sp., Hyatt, 478.
trivolve n. sp., Hyatt, 478.
Lispodesthes nuptialis White, Stanton, 861.
Lithophthorus n. gen., Scudder, 823.
rugosicollis, Scudder, 823.
Litsea
cretacea n. sp., Lesquereux, 582.
falcifolia n. sp., Lesquereux, 582.
Litzea weediana n. sp., Knowlton, 559.
Lomatia saportanea Lesq., Lesquereux, 582.
Loxonema
altivolvis n. sp., Whiteaves, 1035.
cingulatum n. sp., Whiteaves, 1035.
gracillimum n. sp., Whiteaves, 1035.
Lucapina suffusa Reeve, Dall, 215.
Lucina
juvenis n. sp., Stanton, 861.
subundata H. and M., Stanton, 861.
Lunatia
concinna Hall and Meek (sp.), Stanton, 861.
halli, Whitfield, 1036.
halli Gabb, Whitfield, 1036.
Luxonema winnipegense n. sp., Whiteaves, 1029.
Lyria
costata Sowerby, Dall, 215.
musicina Heilprin, Dall, 215.
pulchella Sowerby, Dall, 215.
Macclintockia
cretacea Heer, Lesquereux, 582.
trinervis Heer, Dawson, 239.
Maclurea manitobensis, Whiteaves, 1029.
Macrochilina
blairi n. sp., Miller, 670.
pulchella n. sp., Whiteaves, 1035.
Macrodon pygmæus n. sp., Whiteaves, 1035.
Macrotæniopteris vancouverensis n. sp., Dawson, 239.
Macrorhoptus intutus, Scudder, 823.
Mactra
emmonsi Meek, Stanton, 861.
huerfanensis n. sp., Stanton, 861.
(Cymbophora?) utahensis Meek, Stanton, 861.
Magdalis sedimentorum, Scudder, 823.
Magnolia
alternans Heer, Lesquereux, 582.
amplifolia Heer, Lesquereux, 582.
boulayana n. sp., Lesquereux, 582.

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Genera and species described—Continued.
Magnolia
capellini Heer, Dawson, 239.
lacoeana n. sp., Lesquereux, 582.
obtusata Heer, Lesquereux, 582.
occidentalis n. sp., Dawson, 239.
pseudoacuminata n. sp., Lesquereux, 582.
tenuifolia Lesq., Lesquereux, 582.
Manteodon subquadratus Cope, Earle, 281.
Margarita
abyssina, Whitfield, 1036.
tampaensis n. sp., Dall, 215.
Margaritella abbotti, Whitfield, 1036.
Marginella
(apicina Menke var.?) pardallis Dall, Dall, 215.
aurora n. sp., Dall, 215.
ballista n. sp., Dall, 215.
(ballista var.?) tempæ Dall, Dall, 215.
bella Conrad, Dall, 215.
denticulata Conrad, Dall, 215.
elegantula n. sp., Dall, 215.
eulima n. sp., Dall, 215.
faunula n. sp., Dall, 215.
floridana n. sp., Dall, 215.
gravida n. sp., Dall, 215.
limatula Conrad, Dall, 215.
newmani n. sp., Dall, 215.
onchidella n. sp., Dall, 215.
precursor n. sp., Dall, 215.
semen Lea, Dall, 215.
styria Dall, Dall, 215.
virginiana Conrad, Dall, 215.
willcoxiana n. sp., Dall, 215.
(Volutella) amiantula n. sp., Dall, 215.
dacria n. sp., Dall, 215.
Mariacrinus
aureatus n. sp., Miller, 670.
granulosus n. sp., Miller, 670.
Mariopteris
mazoniana Lx. sp., White, 1022.
(Pseudopecopteris) decipiens Lx. sp., White, 1022.
Masteutes n. gen., Scudder, 823.
rupis, Scudder, 823.
saxifer, Scudder, 823.
Mastodon successor n. sp., Cope, 175.
Matheria rugosa n. sp., Ulrich, 940.
Mazzalina
costata n. sp., Dall, 215.
oweni Dall, Dall, 215.
Meekella White and St. John, Hall, 383.
Meioceras cingulatum n. sp., Dall, 215.
Megalichthys macropomus n. sp., Cope, 179.
Megalograptus, James, 491.
welchi, James, 491.
Megalonyx, Safford, 802.
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Melongena
corona Gmelin, Dall, 215.
sculpturata var. turricula, Dall, 215.
subcoronata var. aspinosa, Dall, 215.
Melocrinus
gregari n. sp., Rowley, 790.
oblongus n. sp., Wachsmuth and Springer, 974.

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Genera and species described—Continued.
Melocrinus
parvus n. sp. Wachsmuth and Springer, 974.
roemeri n. sp., Wachsmuth and Springer, 974.
Meniscœssus Cope, Osborn, 701.
Menispermites rugosus n. sp., Lesquereux, 582.
Menodus augustigenis, Ami, 18.
Merista Suess, Hall, 384.
Meristella Hall, Hall, 384.
Meristina Hall, Hall, 384.
Mesalia elongata n. sp., Whitfield, 1036.
Mesohippus, Scott, 818.
Mesostoma occidentalis n. sp., Stanton, 861.
Mesothyra, Clarke, 146.
Mesotreta Kutorga, Hall, 383.
Metacoceras
cavatiformis, Hyatt, 478.
dubium n. sp., Hay 404.
hayi n. sp., Hay, 404.
inconspicum n. sp., Hay, 404.
walcotti, Hyatt, 478.
Metacypris
consobrina n. sp., Jones, 506.
cuneiformis n. sp., Jones, 506.
simplex n. sp., Jones, 506.
subcordata n. sp., Jones, 506.
Metaplasia n. gen., Hall, 384.
Miacis canavus Cope, Osborn and Wortman, 699.
Michelinia convexa D'Orbigny, Beecher, 57.
Mickwitzia Schmidt, Hall, 383.
Microdus dumbellii n. sp., Cope, 182.
Microspongia, James, 491.
gregaria, James, 491.
(?) subrotundus, James, 491.
Mimulus Barrande, Hall, 383.
Mitra
holmesii n. sp., Dall, 215.
lineolata Heilprin, Dall, 215.
(mississippiensis var.?) silicata Dall, Dall, 215.
sp. undet., Dall, 215.
wandoensis Holmes, Dall, 215.
wilcoxii n. sp., Dall, 215.
Mitromorpha
cincta n. sp., Dall, 215.
pygmæa Dall, Dall, 215.
Modiola
branneri n. sp., Hill, 435.
filisculpta n. sp., Cragin, 186.
jurafacies n. sp., Cragin, 186.
stonewallensis n. sp., Cragin, 186.
(Brachydontes) multilinigera Meek, Stanton, 861.
Modiolopsis
concava n. sp., Ulrich, 940.
corrugata n. sp., Miller and Faber, 672.
longus n. sp., Miller and Faber, 672.
plana Hall, Ulrich, 940.
similis n. sp., Ulrich, 940.
subelliptica n. sp., Ulrich, 940.
sulcata n. sp., Miller and Faber, 672.

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Genera and species described—Continued.
Modiomorpha
attenuata, Whiteaves, 1035.
compressa n. sp., Whiteaves, 1035.
parvula n. sp., Whiteaves, 1035.
tumida n. sp., Whiteaves, 1035.
Modulus
compactus n. sp., Dall, 215.
floridanus Conrad, Dall, 215.
lapidosa n. sp., Whitfield, 1036.
turbinatus Heilprin, Dall, 215.
willcoxii n. sp., Dall, 215.
Molleria duplinensis n. sp., Dall, 215.
Monobolina Salter, Hall, 383.
Monocladodus
clarki, Claypole, 154.
pinnatus, Claypole, 154.
Monomerella Billings, Hall, 383.
egani n. sp., Hall, 383.
greenii n. sp., Hall, 383.
kingi n. sp., Hall, 383.
ortoni n. sp., Hall, 383.
Monotrypa incerta n. sp., Ami, 12.
Monticulipora
filiasa, James, 491.
irregularis, James, 491.
turbinata, James, 491.
undulata, James, 491.
undulata var. hemispherica n. var., James 491.
Morea naticella, Whitfield, 1036.
Mortoniceras
shoshonense Meek, Stanton, 861.
vermillionense M. and H., Stanton, 861.
Mosasauridæ, Baur, 39.
Murchisonia sp., Calvin, 112.
archiacana (nom. nov.), Whiteaves, 1035.
dowlingii n. sp., Whiteaves, 1035.
Murex
chrysostoma Gray var. chipolana Dall Dall, 215.
mississippiensis Conrad, Dall, 215.
(Chicoreus?)
burnsii Whitfield, Dall, 215.
micromeris n. sp., Dall, 215.
(Pteronotus) lævavaricosus n. sp., Whitfield, 1036.
textilis Gabb, Dall, 215.
(Pterorhytis)
conradi, Dall, 215.
umbrifer Conrad, Dall, 215.
Muricidea
floridana Conrad, Dall, 215.
multangula Philippi, Dall, 215.
spinulosa Heilprin, Dall, 215.
Myalina trigonalis n. sp., Whiteaves, 1035.
Mycetophætus n. gen., Scudder, 824.
intermedius, Scudder, 824.
Myelodactylus gorbyi n. sp., Miller, 670.
Mylacris pacardii, Scudder, 826.
Mylodon? sodalis Cope, Cope, 183.
Myrica
aspera n. sp., Lesquereux, 582.
emarginata Heer, Lesquereux, 582.
longa Heer, Lesquereux, 582.

Paleontology—Continued.
Genera and species described—Continued.
Myrica
obliqua n. sp., Lesquereux, 582.
schimperi n. sp., Lesquereux, 582.
Myrsine crassa n. sp., Lesquereux, 582.
Myrsinites? gaudina Lesq., Lesquereux, 582.
Myrtophyllum warderi n. sp., Lesquereux, 582.
Mytilarca inflata n. sp., Whiteaves, 1035.
Nassa
bidentata Emmons, Dall, 215.
caloosaensis n. sp., Dall, 215.
harpuloides Conrad, Dall, 215.
johnsoni n. sp., Dall, 215.
lapenotierei n. sp., Dall, 215.
scalaspira Conrad, Dall, 215.
Nassarina glypta Bush., Dall, 215.
Natica
abyssina, Whitfield, 1036.
abyssina Morton, Whitfield, 1036.
alticallosa n. sp., Dall, 215.
globulella n. sp., Whitfield, 1036.
humilis n. sp., Cragin, 186.
striaticostata n. sp., Cragin, 186.
(Cryptonatica) floridana n. sp., Dall, 215.
Naticopsis
inornata n. sp., Whiteaves, 1035.
manitobensis n. sp., Whiteaves, 1035.
Nautilus
bryani, Whitfield, 1036.
cookana n. sp., Whitfield, 1036.
dekayi, Whitfield, 1036.
elegans Sowerby, Stanton, 861.
texanus Shum., Cragin, 186.
Nemodon sulcatinus Evans and Shumard (sp.)?, Stanton, 861.
Neobolus Waagen, Hall, 383.
Neptunella mullicaensis n. sp., Whitfield, 1036.
Nerinea
hicoriensis n. sp., Cragin, 186.
pellucida n. sp., Cragin, 186.
volana n. sp., Cragin, 186.
Nerita tampaensis n. sp., Dall, 215.
Neritina
apparata n. sp., Cragin, 186.
chipolana n. sp., Dall, 215.
incompta White, Stanton, 861.
pisum Meek, Stanton, 861.
(Theodoxus?) edentula n. sp., Dall, 215.
(Velatella) patelliformis Meek, Stanton, 861.
Neritopsis
biangulatus Shum., Cragin, 186.
tramitensis n. sp., Cragin, 186.
Neumayria walcotti Hill, Hill, 435.
Neuropteris
angustifolia Brongn., White, 1022.
caudata n. sp., White, 1022.
cordata, White, 1022.
dilatata (L. and H.) Lx., White, 1022.
fasciculata Lx., White, 1022.
fimbriata Lx., White, 1022.
flexuosa Sternb., White, 1022.
hirsuta Lx., White, 1022.
jenneyi n. sp., White, 1022.
rarinervis Bunb., White, 1022.

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Genera and species described—Continued.
Neuropteris
scheuchzeri Hoffm., White, 1022.
tenuifolia (Schloth.) Sternb., White, 1022.
cf. trichomanoides (Brongn.) Lx., White, 1022.
Niso
lineata Conrad, Dall, 215.
willcoxiana Dall, Dall, 215.
Nœggerathiopsis robinsi n. sp., Dawson, 239.
Nosotetocus n. gen., Scudder, 824.
marcovi, Scudder, 824.
Nucleospira Hall, Hall, 384.
indianensis n. sp., Miller, 670.
Nucula
coloradoensis n. sp., Stanton, 861.
manitobensis n. sp., Whiteaves, 1035.
Numitor n. gen., Scudder, 823.
claviger, Scudder, 823.
Obeliscus conellus n. sp., Whitfield, 1036.
Obolella Billings, Hall, 383.
Obolus Eichwald, Hall, 383.
(Botsfordia) pulchra Matthew, 654.
Odontofusus n. gen., Whitfield, 1036.
medians n. sp., Whitfield, 1036.
rostellaroides n. sp., Whitfield, 1036.
slacki, Whitfield, 1036.
typicus n. sp., Whitfield, 1036.
Odontostornia
(Syrnola)
attenuata n. sp., Dall, 215.
caloosaensis n. sp., Dall, 215.
Oehlertella n. subgen., Hall, 383.
Olcostephanus (Astieria) deansii n. sp., Whiteaves, 1030.
Olivella
lata n. sp., Dall, 215.
mutica Say, Dall, 215.
Ollacrinus papillatus, Whitfield, 1037.
Omileus evanidus, Scudder, 823.
Omphalocrinus manitobensis, Whiteaves, 1035.
Oncodoceras n. gen., Hyatt, 478.
Onychaster
asper n. sp., Miller, 670.
confragosus n. sp., Miller, 670.
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diversifolius n. sp., Lesquereux, 582.
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Scaphella
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(Aurinia)
mutabilis Conrad, Dall, 215.
virginiana Conrad, Dall, 215.
(Aurinia?) striata Gabb, Dall, 215.
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Scaphiocrinus
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(Eunaticina?) textilis n. sp., Stanton, 861.
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Smilax
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Spirifera
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Spodotribus n. gen., Scudder, 823.
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barrandei, Scudder, 823.
Stenogomphus n. gen., Scudder, 824.
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Stenopoceras n. gen., Hyatt, 478.
Stephanocrinus
elongatus n. sp., Miller, 670.
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Strophalosia King, Hall, 383.
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Strophomena
avata n. sp., Matthew, 653.
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Taxocrinus
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Technophorus
divaricatus n. sp., Ulrich, 937.
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filistriatus n. sp., Ulrich, 937.
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Tellina
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Tellinomya
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intermedia n. sp., Ulrich, 940.
longa n. sp., Ulrich, 937.
nitida n. sp., Ulrich, 940.
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canaliculata Say, Dall, 215.
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Trigonia
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(Epidromus) præcedens n. sp., Whitfield, 1036.
Tritonidea
huerfanensis n. sp., Stanton, 861.
obesa n. sp., Whitfield, 1036.
pauper n. sp., Dall, 215.
Tritonium kanabense n. sp., Stanton, 861.
Troostocrinus nitidulus n. sp., Miller and Gurley, 673.
Trophon (Aspella) engonatus n. sp., Dall, 215.
Tropideres
remotus, Scudder, 823.
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Trypanorhynchus n. gen, Scudder, 823.
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Turbinella
chipolana n. sp., Dall, 215.
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polygonata Heilprin, Dall, 215.
regina Heilprin, Dall, 215.
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wilsoni Conrad, Dall, 215.
(Vasum)
haitense Sowerby var. engonatum, Dall, 215.
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Turbinopsis
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elevata n. sp., Whitfield, 1036.
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chipolana n. sp., Dall, 215.
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protracta n. sp., Dall, 215.
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pusilla C. B. Adams, Dall, 215.
recticulata C. B. Adams, Dall, 215.
speira Ravenel?, Dall, 215.
stricta Verrill, Dall, 215.
textilis Kurtz, Dall, 215.
virga Dall, Dall, 215.
virgata Dall, Dall, 215.
(Ondina) fragilis n. sp., Dall, 215.
Turricula
leda n. sp., Whitfield, 1036.
reileyi n. sp., Whitfield, 1036.
scalariformis n. sp., Whitfield, 1036.
Turrilites pauper n. sp., Whitfield, 1036.
Turritella
apicalis Heilprin, Dall, 215.
chipolana n. sp., Dall, 215.
coalvillensis Mk., Cragin, 186.
compacta n. sp., Whitfield, 1036.
encrinoides, Whitfield, 1036.
granulicostata, Whitfield, 1036.
hardimanensis, Whitfield, 1036.
lippincotti n. sp., Whitfield, 1036.
megalobasis n. sp., Dall, 215.
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renauxiana D'Orb., Cragin, 186.
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subannulata Heilprin, Dall, 215.
subgrundifera n. sp., Dall, 215.
tampæ Heilprin, Dall, 215.
var. pagodæformis Heilprin, Dall, 215.
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terebriformis n. sp., Dall, 215.
verterbroides, Whitfield, 1036.
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Tychius
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Typhis
floridanus Dall, Dall, 215.
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Tylostoma
mutabilis Gabb, Cragin, 186.
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Uintacrinus socialis Grinnell, Clark, 139.
Ulmophyllum priscum n. sp., Dawson, 239.
Ulocrinus n. gen., Miller and Gurley, 673.
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Vaginella chipolana n. sp., Dall, 215.
Vasum conoides n. sp., Whitfield, 1036.

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Venus malonensis n. sp., Cragin, 186.
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robustum n. sp., Lesquereux, 582.
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latius n. var., Lesquereux, 582.
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WASHINGTON, D. C.

WASHINGTON, D. C., *July, 1895.*

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UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

REPORT OF PROGRESS

OF THE

DIVISION OF HYDROGRAPHY

FOR

THE CALENDAR YEARS 1893 AND 1894

BY

FREDERICK HAYNES NEWELL

TOPOGRAPHER IN CHARGE



WASHINGTON

GOVERNMENT PRINTING OFFICE

1895

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LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
DIVISION OF HYDROGRAPHY,
Washington, D. C., May 20, 1895.

SIR: I have the honor to transmit herewith a manuscript entitled "Report of progress of the Division of Hydrography for the calendar years 1893 and 1894," and to request that it be published as a bulletin of the Survey.

Very respectfully, yours,

F. H. NEWELL,
Topographer in Charge.

Hon. CHARLES D. WALCOTT,
Director United States Geological Survey.

REPORT OF PROGRESS OF THE DIVISION OF HYDROGRAPHY FOR 1893 AND 1894.

By F. H. Newell.

INTRODUCTION.

This bulletin contains the results of observations and measurements made by the Division of Hydrography during the calendar years 1893 and 1894, together with similar facts obtained by persons or officials cooperating with the Survey or conducting related lines of investigation. It has not been customary to publish results until the computations have been fully worked up and the matter has been put into the most concise form possible for insertion in one of the papers accompanying the Annual Report; but experience has shown the desirability of printing at as early date as possible much of the original data regarding the location of the river stations and daily observations, as these are becoming to be matters of importance to individuals and communities in different parts of the country. In the past all facts of this kind have been furnished by letter to persons requesting them, but a time has been reached when it seems economical and advisable to present these matters in form accessible to all persons. It is proposed, therefore, to publish in bulletin form, without illustrations, the data obtained during each field season, reserving the more condensed general statements and the results of final computations, as before, for the Annual Report of the Survey, wherein they will be presented, as far as possible, graphically, by means of maps and diagrams. In one of the annual reports succeeding this bulletin will be given a resume of some of the data herewith presented. This will be the sixth paper of the series.[1]

The field seasons for the years 1893 and 1894 marked the time of greatest depression for the Division of Hydrography and the beginning of a period of renewed activity. During 1893 and the earlier

[1] The five preceding papers are as follows: Hydrographic Work: First Annual Report of the Irrigation Survey, being Part II of the Tenth Annual Report of the United States Geological Survey, pp. 78–90. Hydrography: Second Annual Report of the Irrigation Survey, being Part II of the Eleventh Annual Report of the United States Geological Survey, pp. 1–110. Hydrography of the Arid Regions: Third Annual Report of the Irrigation Survey, being Part II of the Twelfth Annual Report of the United States Geological Survey. pp. 213–361. Water Supply for Irrigation: Thirteenth Annual Report of the United States Geological Survey, Part III, pp. 1–99. Results of Stream Measurements: Fourteenth Annual Report of the United States Geological Survey, Part II, pp. 89–155.

months of the following year the allotments for stream measurements barely sufficed to continue the reading and recording of heights of rivers at a number of the stations previously established, and were not large enough to maintain field work, nor to replace river gages as these were washed out, nor to verify the rating tables constructed for various localities. Many stations, therefore, for which excellent rating tables had been prepared during 1889, 1890, and succeeding years had to be abandoned for one cause or another, and in the case of others the change of shape of river channel and the altered relation of gage height to discharge rendered of doubtful value the computations of daily flow. In August of 1894, however, the work was again taken up with vigor, owing to favorable action by Congress. New stations were established, and many old ones of value were inspected and renewed.

In this connection it will be proper to cite the laws under which this investigation is being conducted, or which bear directly upon its operations, and to give a short resume of the existing legislation.

LEGISLATION.

In 1887 the Director of the Geological Survey was called upon by Congress to consider the question of Federal recognition of the irrigation subject. A resolution was introduced and passed directing the Secretary of the Interior, by means of the Director of the Geological Survey, to make an investigation of that portion of the arid region of the United States where agriculture is carried on by means of irrigation. The resolution reads as follows:

> Whereas a large portion of the unoccupied public lands of the United States is located within what is known as the arid region and now utilized only for grazing purposes, but much of which, by means of irrigation, may be rendered as fertile and productive as any land in the world, capable of supporting a large population thereby adding to the national wealth and prosperity;
>
> Whereas all the water flowing during the summer months in many of the streams of the Rocky Mountains, upon which chiefly the husbandman of the plains and the mountain valleys chiefly depends for moisture for his crops, has been appropriated and is used for the irrigation of lands contiguous thereto, whereby a comparatively small area has been reclaimed; and
>
> Whereas there are many natural depressions near the sources and along the courses of these streams which may be converted into reservoirs for the storage of the surplus water which during the winter and spring seasons flows through the streams; from which reservoirs the water there stored can be drawn and conducted through properly constructed canals, at the proper season, thus bringing large areas of land into cultivation, and making desirable much of the public land for which there is now no demand; therefore be it
>
> *Resolved by the Senate and House of Representatives of the United States of America in Congress assembled*, That the Secretary of the Interior by means of the Director of the Geological Survey be, and he is hereby, directed to make an examination of that portion of the arid regions of the United States where agriculture is carried on by means of irrigation, as to the natural advantages for the storage of water for irrigating purposes with the practicability of constructing reservoirs, together with the capacity of the streams and the cost of construction and capacity of reservoirs, and such other facts as bear on the question of storage of water for irrigating pur-

poses; and that he be further directed to report to Congress as soon as practicable the result of such investigation. (Joint resolution approved March 20, 1888; Statutes at Large, vol. 25, p. 618.)

This was followed by the passage of an act containing an appropriation of $100,000 for the purpose of investigating the extent to which the arid region of the United States can be redeemed by irrigation. This act is as follows:

For the purpose of investigating the extent to which the arid region of the United States can be redeemed by irrigation, and the segregation of the irrigable lands in such arid region, and for the selection of sites for reservoirs and other hydraulic works necessary for the storage and utilization of water for irrigation and the prevention of floods and overflows, and to make the necessary maps, including the pay of employees in field and in office, the cost of all instruments, apparatus, and materials, and all other necessary expenses connected therewith, the work to be performed by the Geological Survey, under the direction of the Secretary of the Interior, the sum of one hundred thousand dollars or so much thereof as may be necessary. And the Director of the Geological Survey under the supervision of the Secretary of the Interior shall make a report to Congress on the first Monday in December of each year, showing in detail how the said money has been expended, the amount used for actual survey and engineer work in the field in locating sites for reservoirs and an itemized account of the expenditures under this appropriation. And all the lands which may hereafter be designated or selected by such United States surveys for sites for reservoirs, ditches or canals for irrigation purposes and all the lands made susceptible of irrigation by such reservoirs, ditches or canals are from this time henceforth hereby reserved from sale as the property of the United States, and shall not be subject after the passage of this act, to entry, settlement or occupation until further provided by law:

Provided, That the President may at any time in his discretion by proclamation open any portion or all of the lands reserved by this provision to settlement under the homestead laws. (Sundry civil act approved October 2, 1888; Statutes at Large, vol. 25, p. 526.)

In the following year $250,000 was appropriated for continuing this work. (Sundry civil act approved March 2, 1889.)

A portion of the law passed October 7, 1888, was repealed by the following provision in the sundry civil act approved August 30, 1890, and no appropriation was made for irrigation work as such:

And so much of the act of October 2, 1888, entitled "An act making appropriations for sundry civil expenses of the Government for the fiscal year ending June 30th, 1889, and for other purposes," as provides for the withdrawal of the public lands from entry, occupation and settlement, is hereby repealed, and all entries made or claims initiated in good faith and valid but for said act, shall be recognized and may be perfected in the same manner as if said law had not been enacted, except that reservoir sites heretofore located or selected shall remain segregated and reserved from entry or settlement as provided by said act until otherwise provided by law, and reservoir sites hereafter located or selected on public lands shall in like manner be reserved from the date of the location or selection thereof.

No person who shall after the passage of this act, enter upon any of the public lands with a view to occupation, entry or settlement under any of the land laws shall be permitted to acquire title to more than three hundred and twenty acres in the aggregate, under all of said laws, but this limitation shall not operate to curtail the right of any person who has heretofore made entry or settlement on the public lands, or whose occupation, entry or settlement, is validated by this act: Provided,

That in all patents for lands hereafter taken up under any of the land laws of the United States or on entries or claims validated by this act west of the one hundredth meridian, it shall be expressed that there is reserved from the lands in said patent described, a right of way thereon for ditches or canals constructed by the authority of the United States. (Sundry civil act approved August 30, 1890; Statutes at Large, vol. 26, p. 391.)

From this it appears that the portion of the original law approved October 2, 1888, which affected the withdrawal of the public lands from entry, occupation, and settlement was repealed, but that the remaining portions of the law were unaffected by the act of repeal, and there is still on the statute books authority for making an examination of the arid region of the United States, for ascertaining the capacity of the streams, and "for the selection of sites for reservoirs and other hydraulic works necessary for the storage and utilization of water for irrigation and the prevention of floods and overflows, and to make the necessary maps."

In the repealing act it was specifically provided that the reservoir sites shalt remain segregated, and in an act entitled "An act to repeal timber-culture laws, and for other purposes," approved March 3, 1891, it is provided:

That reservoir sites located or selected and to be located and selected under the provisions of "An act making appropriations for sundry civil expenses of the Government for the fiscal year ending June thirtieth, eighteen hundred and eighty-nine, and for other purposes," and amendments thereto, shall be restricted to and shall contain only so much land as is actually necessary for the construction and maintenance of reservoirs; excluding so far as practicable lands occupied by actual settlers at the date of the location of said reservoirs. (Statutes at Large, vol. 26, p. 1101.)

Under the various laws above cited, systematic measurements of the streams of the arid regions were begun as part of the irrigation survey, and were continued after August 30, 1890, as incidental to the topographic surveys and selection of reservoir sites, the amounts allotted to this work being, however, as previously stated, barely sufficient to preserve from loss the valuable data already obtained and to continue to completion series of measurements for which by far the greater part of the necessary expenditures had been incurred. The publication and diffusion of the information relating to streams of the West, even though fragmentary, brought emphatically to public attention the necessity of such work and of obtaining more detailed facts concerning the water resources of all parts of the country. As a result of this general appreciation, Congress, by act of August 18, 1894, made a specific appropriation for this class of work, as follows:

For gaging the streams and determining the water supply of the United States, including the investigation of underground currents and artesian wells in the arid and semiarid sections, twelve thousand five hundred dollars. (Digest of Appropriations for 1895, p. 270.)

A further appropriation by act approved March 2, 1895, will make available on July 1, 1895, an additional sum for continuing this work until June 30, 1896. This bulletin, as relating to the field work for

the years 1893 and 1894, covers the results obtained under the small allotments previously made and the inception of the work under the specific appropriation of August 18, 1894.

A general summary of the more important results obtained in previous years may be found in the Tenth to the Fourteenth Annual Reports of the Director of this Survey (see footnote on p. 9), and in a monograph upon Agriculture by Irrigation, published as one of the volumes of the Eleventh Census of the United States, in which the figures obtained by the enumerators of the Eleventh Census and facts gathered on schedules and suitable blanks by extensive correspondence were elaborated and supplemented by the field information and experience acquired by the members of the Division of Hydrography of this Survey.

FIELD WORK IN 1893 AND 1894.

The field work of this division for the year 1893 and for the first half of 1894 was carried on by Mr. F. H. Newell. It consisted of inspection of river stations, verification of rating tables by measurements of discharge, and examination of local conditions influencing water supply. In the fall of 1894 Mr. Arthur P. Davis took up the work. He established new river stations, and the investigation was extended generally. Prof. Robert Hay was also employed temporarily to make an investigation of the so-called "underflow" and subsurface waters of the area extending from the North Platte River southerly along the one hundred and second meridian, across a portion of Kansas and into eastern Colorado and western Kansas. His conclusions and generalizations have been prepared for publication in a paper accompanying the Sixteenth Annual Report of the Director, while the somewhat detailed data upon which many of his conclusions are based are given herewith, as part of this bulletin, in order that they may be accessible to the relatively limited number of persons who will care to utilize them.

The results of the river work are shown in connection with the descriptions of the stations, and are summarized briefly in the list of discharge measurements. In the descriptions of these stations the geographic order employed in former reports is adhered to. The Upper Missouri and its tributaries are taken up first; then the Platte, Arkansas, Rio Grande, and Colorado basins; next the great interior basin, of which the streams tributary to the lakes or sinks in Nevada, and to Great Salt Lake and Sevier Lake in Utah, are parts; then the Snake and its tributaries, and the other rivers forming portions of the Columbia River system; then the Sacramento, San Joaquin, and creeks of southern California; and lastly the data obtained concerning streams in the Mississippi Valley and along the Atlantic watershed.

The methods of river measurement are described in the Fourteenth Annual Report, Part II, pages 96–101, where are given also a number of illustrations of the current meters and self-recording devices used in river work.

UPPER MISSOURI BASIN IN MONTANA.

The river stations on the West Gallatin and Madison rivers, described in former reports, have been abandoned, owing to the difficulty and expense of reaching them. Other stations have been established lower down on the rivers, near the junction of the Gallatin, Madison, and Jefferson, but above the point where they unite to form the Missouri. On the Missouri itself, near Townsend, a number of discharge measurements have been made at the place where the record of height is being kept by the Missouri River Commission, in order to furnish material for computing the total run-off from this drainage area.

SPANISH CREEK STATION, ON WEST GALLATIN RIVER.

This station was established August 17, 1889, by Mr. J. B. Williams. It is located on the West Gallatin River, about 20 miles southwesterly from Bozeman, Mont., on what is known as Lemon's ranch, about one-half mile above the point where the river emerges from its narrow valley in the mountains. The locality chosen is above the heads of all canals, so that the total flow of the river is obtained. The bed of the river is rocky and not liable to change; the banks are high and steep; the stream is of nearly uniform width, and has a straight course both above and below the station. The section is in every respect suitable, with the possible exception that the bottom is perhaps too rough and rocky, in low water giving rise to riffles. The velocity is also somewhat great for accurate results with the ordinary current meters. During 1889 only two measurements were obtained, these being at about the same stage. In 1890 seven current-meter observations were had, and in 1891 another was obtained. These furnished material for a rating table which has proved to be fairly applicable during the year 1893.

On June 14, 1893, the old river gage was washed away by flood, and was reestablished on August 22, by Mr. F. H. Newell. On the same day a measurement of the river was made at the iron bridge below the mouth of the canyon, showing that for a height of 2.15 feet on the rod the river was flowing at the rate of 818 second-feet. This did not include the quantity flowing in the high-line canal taking water from the right bank of the river. Observations were begun on August 22, 1893, and continued throughout the year, and until June 22, 1894, when, owing to a sudden rise of the river, the gage was again washed out, together with the large tree to which it was attached and the bench marks on the bank of the stream. It not being advisable at that time to relocate the gage, the station was abandoned. At about that time observations of river height were begun at the head of the West Gallatin Canal, which takes water out on the left-hand or west side of the river, near the iron bridge, a short distance from the mouth of the canyon. These were begun on May 27 and continued to June 30, 1894, a time not sufficiently long to justify rating the station.

The estimates of discharge have already been published for the year 1893, but owing to the uncertainty as to the exact position of the river rod after the ice went out it has not been considered advisable to attempt to apply the former rating table showing the relation between gage height and discharge for the period from January 1 to June 30. The figures of height indicate, however, that the river continued at its low stage of probably between 300 and 400 second-feet until about the first week in April, when a slight rise took place, followed by the gradual increase of volume during the latter part of April and early May, the spring flood beginning a few weeks earlier than in the preceding year. In the latter part of May and early June the flood reached its greatest intensity, being in volume probably over 7,000 cubic feet per second. By the middle of the latter month it had fallen to less than 2,000 second-feet, the gradual fall being interrupted by a sudden flood on April 23, which washed out the river rod and with it the old tree upon the bank. This flood, therefore, must have been of unusual intensity, as the banks at this point are high, firm, and covered with heavy timber.

Rating table for the West Gallatin River at Spanish Creek station, Montana.

[Applicable for 1893 and, with doubtful accuracy, for the spring of 1894.]

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
	Sec. feet.		*Sec. feet.*		*Sec. feet.*		*Sec. feet.*
1.00	.....	3.00	1,480	5.00	3,580	7.00	5,900
1.10	.....	3.10	1,570	5.10	3,690	7.10	6,030
1.20	.....	3.20	1,660	5.20	3,800	7.20	6,160
1.30	.....	3.30	1,760	5.30	3,910	7.30	6,290
1.40	280	3.40	1,860	5.40	4,020	7.40	6,410
1.50	320	3.50	1,960	5.50	4,130	7.50	6,540
1.60	370	3.60	2,060	5.60	4,280	7.60	6,670
1.70	430	3.70	2,165	5.70	4,350	7.70	6,800
1.80	500	3.80	2,270	5.80	4,460	7.80	6,930
1.90	570	3.90	2,375	5.90	4,570	7.90	7,060
2.00	650	4.00	2,480	6.00	4,690	8.00	.....
2.10	730	4.10	2,590	6.10	4,810	8.10	.....
2.20	810	4.20	2,700	6.20	4,930	8.20	.....
2.30	890	4.30	2,810	6.30	5,000	8.30	.....
2.40	970	4.40	2,920	6.40	5,170	8.40	.....
2.50	1,050	4.50	3,030	6.50	5,290	8.50	.....
2.60	1,130	4.60	3,140	6.60	5,440	8.60	.....
2.70	1,210	4.70	3,250	6.70	5,530	8.70	.....
2.80	1,300	4.80	3,360	6.80	5,650	8.80	.....
2.90	1,390	4.90	3,470	6.90	5,770	8.90	.....

Daily gage height of West Gallatin River at Spanish Creek station for 1893.

Day.	Jan.	Mar.	Apr.	May.	June.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.80	.....	1.70	1.80	3.35	.....	1.90	1.90	1.90	1.70
2	1.80	.....	1.70	1.80	3.55	.....	1.90	2.00	1.90	1.70
3	1.80	.....	1.70	1.80	3.50	.....	1.90	1.95	1.90	1.70
4	1.80	.....	1.70	1.80	3.50	.....	1.90	1.90	1.90	1.70
5	1.80	.....	1.70	1.80	3.50	.....	1.90	1.90	1.80	1.70
6	1.80	.....	1.70	1.80	3.80	.....	1.90	1 90	1.80	1.70
7	1.80	.....	1.70	1.85	4.50	.....	1.90	1.90	1.80	1.70
8	1.80	.....	1.70	2.05	4.70	.....	2.00	2.00	1.80	1.70
9	1.80	.....	1.70	2.30	4.80	.....	1.90	2.00	1.70	1.70
10	1.80	.....	1.70	2.60	5.10	.....	1.90	2.10	1.70	1.70
11	1.80	.....	1.70	2.50	6.50	.....	1.90	2.05	1.70	1.70
12	1.80	.....	1.70	2.75	7.00	.....	1.90	2.00	1.70	1.70
13	1.80	.....	1.70	3.00	6.90	.....	1.90	2.00	1.70	1.70
14	1.80	.....	1.70	3.20	6.50	.....	1.90	1.90	1.70	1.70
15	1.80	.....	1.70	3.50	(*a*)	.....	1.90	1.90	1.70	1.70
16	1.80	.....	1.70	4.20	.....	.....	1.95	1.90	1.70	1.70
17	1.80	.....	1.80	4.80	.....	.....	2.00	1.90	1.70	1.60
18	1.70	.....	1.80	4.70	.....	.....	2.00	1.90	1.70	1.60
19	1.70	1.70	1.80	3.90	.....	.....	2.00	1.90	1.70	1.60
20	1.70	1.70	1.80	3.55	.....	.....	2.00	1.90	1.70	1.60
21	1.70	1.70	1.80	3.35	.....	.....	2.00	1.90	1.70	1.60
22	1.70	1.60	1.80	3.20	.....	2.10	1.90	1.90	1.70	1.60
23	1.70	1.60	1.80	3.20	.....	2.10	1.90	1.80	1.70	1.60
24	1.70	1.60	1.80	2.95	.....	2.05	1.90	1.80	1.70	1.60
25	1.70	1.60	1.80	2.85	.....	2.00	1.90	1.80	1.70	1.60
26	1.70	1.60	1.80	2.80	.....	1.90	1.90	1.80	1.70	1.60
27	1.70	1.60	1.80	2.80	.....	1.90	1.90	1.80	1.70	1.60
28	1.70	1.60	1.80	2.85	.....	1.90	1.90	1.80	1.70	1.60
29	1.70	1.70	1.80	2.95	.....	1.90	1.90	1.80	1.70	1.60
30	1.70	1.70	1.80	3.10	.....	1.90	1.90	1.85	.....	1.60
31	1.70	1.70	.....	3.15	.....	1.90	.....	1.90	.....	1.60

a Washout.

Daily gage height of West Gallatin River at Spanish Creek station for 1894.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	Day.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	1.60	1.50	1.50	1.60	2.50	7.40	17	1.50	.....	1.70	1.60	4.00	3.20
2	1.60	1.50	1.50	1.60	2.50	7.70	18	1.50	.....	1.40	1.60	4.00	3.10
3	1.60	1.50	1.50	1.60	2.30	7.30	19	1.50	.....	1.40	1.60	4.30	3.30
4	1.60	1.50	1.40	1.50	2.20	7.30	20	1.50	.....	1.40	1.90	4.90	3.40
5	1.60	1.50	1.40	1.50	2.40	7.00	21	1.50	.....	1.40	2.00	4.90	3.60
6	1.60	1.50	1.40	1.60	2.30	6.80	22	1.50	.....	1.40	2.30	5.00	3.80
7	1.50	1.50	1.40	1.60	2.50	6.40	23	1.50	.....	1.40	2.00	4.70	4.00
8	1.50	1.50	1.40	1.60	2.80	6.20	24	1.50	.....	1.40	2.50	5.30	.....
9	1.50	1.50	1.40	1.70	3.50	6.00	25	1.50	1.6	1.40	2.60	5.50	.....
10	1.50	1.50	1.40	1.90	3.20	5.00	26	1.50	1.6	1.40	2.20	5.70	.....
11	1.50	.....	1.40	1.90	3.20	4.20	27	1.50	1.6	1.50	2.00	5.80	.....
12	1.50	.....	1.40	1.70	2.40	4.10	28	1.50	1.6	1.60	2.10	6.40	.....
13	1.50	.....	1.50	1.60	3.70	3.80	29	1.50	.....	1.60	2.20	6.80	.....
14	1.50	.....	1.60	1.70	4.40	3.20	30	1.50	.....	1.50	2.80	6.90	.....
15	1.50	.....	1.60	1.80	4.30	3.00	31	1.50	.....	1.50	.....	7.00	.....
16	1.50	.....	1.70	1.70	4.00	3.00							

LOGAN STATION, ON GALLATIN RIVER.

This station was established on August 24, 1893, by Mr. F. H. Newell, at the railroad pump house immediately below the Northern Pacific main line bridge crossing Gallatin River at Logan, Mont. The gage was a vertical rod fastened to the cribwork box sunk in the river for the protection of the inlet pipe of the pump. The reading on that date was 0.50, the high water of spring being estimated to be about 4.25 of the gage. The bench marks consist of nails driven into the angle of the pier of the bridge facing the gage, these being placed at the elevation of the 7, 8, 9, and 10 foot marks, and designated by correspond-

ing figures. At the bridge itself measurements of volume can not well be made, as the stream is divided into four channels, being very swift under two of these, and obstructed by piles, snags, and sand under the others. Above the bridge, however, is a broad, straight course, where measurements can be made by means of a boat and cable. Record of the heights of the river was kept at this locality from September 3, 1893, to June 9, 1894, the river being frozen from January 21, 1894, until March 10, 1894, at which time the ice disappeared from the river. The gage rod was finally washed out, together with the crib to which it was attached, no discharge measurements having been made while it was in place.

On November 16, 1894, a new gage was established by Mr. Arthur P. Davis under the northeast corner of the Northern Pacific bridge above mentioned. This gage consisted of timbers partly inclined and partly vertical, the lower inclined portion being graduated from 0.60 feet up to 7.10 feet, and the vertical portion from 7 feet up to 12.10 feet. Bench mark No. 1 is on the head of a bridge spike, in the top of the pile stump to which the lower end of the inclined gage is fastened. It is 0.38 feet below the 2-foot mark on the gage. Bench mark No. 2 is the head of a bridge spike driven horizontally into the first pier east of the river. It is driven into the north end, and is marked "B. M." It is 7.32 feet above the 2-foot mark on the gage. The measurements were made by means of a cable across the river 100 yards above the bridge.

A discharge measurement, made on November 17, when the water stood at the height of 1.11 feet on the gage, showed a volume of 772 second-feet. The width of the stream was 146 feet; the mean depth, 2.9 feet; the maximum depth, 4.6 feet; the mean velocity, 1.82 feet, and the maximum, 2.26 feet. The cross section is excellently adapted to measurements of discharge, having a good gravel bottom. A record of river height was begun on December 16, 1894, and the river was reported as frozen on December 23.

The above figures give the total outflow from the drainage basin of the Gallatin, as the river empties into the Missouri a few miles below. The total area drained is approximately 1,620 square miles, including the Gallatin Valley and the surrounding mountain slopes. Thus the quantity of water discharged at this time represents the amount flowing to waste during the fall, and probably during the winter months. For comparison with this it may be noted that at the gaging station on the West Gallatin, below the mouth of Spanish Creek, the area drained was 850 square miles, and the average flow for November for five years preceding was 490 second-feet.

Daily gage height of Gallatin River at Logan station for 1893.

Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.
1	.....	0.50	0.60	0.30	12	0.40	0.80	0.70	0.60	23	0.60	0.70	0.50	0.50
2	.....	.65	.60	.30	13	.40	.70	.70	.60	24	.60	.70	.40	.50
3	0.40	.80	.75	.30	14	.40	.70	.65	.60	25	.50	.70	.40	.40
4	.40	.90	.80	.40	15	.40	.80	.60	.60	26	.50	.70	.30	.40
5	.40	1.00	.70	.40	16	.40	.70	.60	.50	27	.40	.70	.30	.40
6	.40	.85	.70	.50	17	.50	.70	.60	.50	28	.40	.70	.30	.40
7	.40	.65	.70	.50	18	.50	.70	.50	.50	29	.40	.70	.30	.40
8	.40	.60	.70	.60	19	.50	.80	.50	.50	30	.50	.70	.30	.40
9	.40	.80	.70	.60	20	.50	.80	.50	.50	31	.....	.70	.....	.40
10	.40	.90	.70	.60	21	.60	.70	.50	.50					
11	.40	.90	.70	.60	22	.60	.70	.50	.50					

Daily gage height of Gallatin River at Logan station for 1894.

Day.	Jan.	Mar.	Apr.	May.	June	Dec.	Day.	Jan.	Mar.	Apr.	May	June.	Dec.
1	0.40	.....	1.30	1.60	.....	.....	17	0.40	0.60	0.90	3.20	.....	1.30
2	.40	.....	1.00	1.50	.....	.....	18	.40	.50	.90	3.80	.....	1.30
3	.40	.....	.90	1.50	5.60	.....	19	.40	.50	1 10	3.50	.....	1.30
4	.40	.....	.90	1.40	5.60	.....	20	.40	.60	1.10	3.30	.....	1.20
5	.40	.....	.90	1.40	5.80	.....	21	(*a*)	.70	1.10	3.60	.....	1.20
6	.40	.....	.....	1.60	6.00	.....	22	.....	.80	1.20	3.90	.....	1.20
7	.40	.....	.....	1.60	6.00	.....	23	.....	.70	1.40	3.50	.....	(*b*)
8	.40	.....	1.30	1.70	6.00	.....	24	.....	.60	1.80	3.90	.....	.....
9	.40	.....	1.00	1.80	6.00	.....	25	.....	.60	1.90	4.10	.....	.....
10	.40	.....	.90	1.90	.....	.....	26	.....	.60	1.90	4.50	.....	.....
11	.40	0.80	.90	2.00	.....	.....	27	.....	.60	2.00	.....	.....	.....
12	.40	.80	.90	2.00	.....	.....	28	.....	.90	2.00	.....	.....	.....
13	.40	.80	.80	1.90	.....	.....	29	.....	2.50	1.90	.....	.....	.....
14	.40	.90	.70	2.00	.....	.....	30	.....	2.20	1.80	.....	.....	.....
15	.40	.90	.90	2.00	.....	.....	31	.....	1.40	.....	.....	.....	.....
16	.40	.70	.90	2.50	.....	1.30							

a River frozen January 21 to March 10.
b River frozen December 23 to 31.

RED BLUFF STATION, ON MADISON RIVER.

This station was established on April 4, 1890, by Mr. J. B. Williams, who at that time stated that the station is near the mouth of the canyon which separates the upper and lower Madison valleys. The locality is about 4 miles from the town of Red Bluff, Mont., and is about 1½ miles below Hot Spring Creek, a small stream discharging at that time about 5 second-feet. It was at what was then known as Hayward bridge, 1 mile below the new iron bridge, and could be reached by stage from Bozeman, a distance of 30 miles.

The river at the station has a swift current and a rocky bed, with a high bank on the left side and a low one on the right. The gage established by Mr. Williams was inclined for a space of 5 feet vertically, and above this point was attached to a vertical post. Except at times of unusually high water, the river does not rise more than 4 feet. The bench mark is on the top of a flat rock on the left bank of the river, 50 feet above the section, and is marked "B. M." Its elevation above zero of the gage is 17.64 feet. The river is measured from a box suspended on a five-eighths-inch wire cable. The total width of the river is 280 feet. The discharge is unusually constant, owing, presumably, to the

fact that a large proportion of its water comes from the hot springs in the Yellowstone National Park.

Observations begun on April 4, 1890, were continued uninterruptedly through succeeding years, being taken on alternate days in 1894, and finally discontinued at the end of November, owing to lack of funds. The rating table as given below was constructed from gagings made during 1890 and verified in subsequent years. It is believed to be fairly applicable for 1893, but doubtful for 1894. On August 23, 1893, the river was measured from the new iron bridge, about a mile above the station, and the discharge was estimated to be 1,189 second-feet.

Computations of discharge have been made up to the end of June, 1893, and published in the preceding report, but the measurements made since that time indicate such a change in the rating table that computations of discharge can not be made with any considerable degree of confidence until the position of the gage rod has been verified and further check measurements had. This river, as above stated, is notable for the slight changes occurring from week to week in volume, especially during the fall and winter. Its floods come with extraordinary regularity, and the steady flow is hardly disturbed by storms. The flood of 1894 began, as usual, in the latter part of May, reaching a maximum probably of less than 2,500 second-feet, and fell off in the latter part of July to the ordinary fall and winter flow of 1,000 to 1,200 second-feet.

Rating table for Madison River, near Red Bluff, Montana.

[Applicable for 1893, and with less accuracy for later dates.]

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
	Sec. feet.		*Sec. feet.*		*Sec. feet.*		*Sec. feet.*
1.00	.....	2	1,640	3.00	3,780	4.00	6,180
1.10	.....	2.10	1,790	3.10	4,020	4.10	6,420
1.20	910	2.20	1,960	3.20	4,260	4.20	.....
1.30	990	2.30	2,150	3.30	4,500	4.30	.....
1.40	1,070	2.40	2,360	3.40	4,740	4.40	.....
1.50	1,155	2.50	2,580	3.50	4,980	4.50	.....
1.60	1,240	2.60	2,820	3.60	5,220	4.60	.....
1.70	1,330	2.70	3,060	3.70	5,460	4.70	.....
1.80	1,420	2.80	3,300	3.80	5,700	4.80	.....
1.90	1,520	2.90	3,540	3.90	5,940	4.90	.....

Daily gage height of Madison River at Red Bluff station, Montana, for 1893.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.70	1.50	1.40	1.60	1.40	1.95	2.30	1.50	2.00	2.10	1.70	1.85
2	1.75	1.55	1.40	1.60	1.40	1.95	2.20	1.60	2.00	2.10	1.70	1.80
3	1.70	1.60	1.40	1.55	1.50	1.95	2.15	1.60	2.05	2.05	1.65	1.85
4	1.65	1.60	1.40	1.50	1.50	1.95	2.10	1.60	2.05	2.05	1.70	1.85
5	1.60	1.60	1.40	1.45	1.55	2	2.05	1.60	2.10	2.00	1.70	1.80
6	1.60	1.70	1.40	1.40	1.50	2.10	2.00	1.70	2.10	2.00	1.70	1.80
7	1.65	2.00	1.40	1.40	1.55	2.10	2.00	1.80	2.05	2.00	1.70	1.75
8	1.65	2.00	1.40	1.40	1.60	2.15	2.00	1.85	2.05	2.00	1.75	1.75
9	1.65	2.20	1.40	1.40	1.70	2.20	2.00	1.90	2.00	1.90	1.75	1.70
10	1.60	2.20	1.40	1.35	1.70	2.25	1.90	1.90	2.00	1.90	1.75	1.70
11	1.60	2.20	1.40	1.35	1.80	2.30	1.85	2.00	2.00	1.90	1.75	1.70
12	1.60	2.00	1.40	1.40	1.80	2.40	1.80	2.00	2.00	1.85	1.75	1.70
13	1.65	1.90	1.45	1.45	1.80	2.45	1.75	2.00	2.00	1.85	1.75	1.70
14	1.65	1.70	1.45	1.40	1.75	2.50	1.75	2.05	2.05	1.80	1.80	1.75
15	1.65	1.60	1.45	1.30	1.70	2.60	1.70	2.10	2.05	1.80	1.75	1.70
16	1.60	1.50	1.40	1.25	1.75	2.60	1.70	2.10	2.05	1.80	1.80	1.75
17	1.60	1.50	1.35	1.20	1.70	2.70	1.60	2.00	2.00	1.80	1.80	1.75
18	1.55	1.40	1.35	1.20	1.70	2.70	1.60	2.00	2.00	1.80	1.85	1.75
19	1.50	1.40	1.35	1.20	1.70	2.70	1.60	2.05	2.00	1.80	1.85	1.70
20	1.50	1.35	1.40	1.20	1.70	2.65	1.50	2.10	1.90	1.80	1.85	1.75
21	1.50	1.35	1.40	1.20	1.70	2.70	1.50	2.10	1.95	1.80	1.85	1.80
22	1.50	1.35	1.35	1.20	1.75	2.75	1.50	2.10	2.00	1.80	1.80	1.80
23	1.50	1.40	1.40	1.20	1.75	2.70	1.40	2.10	2.05	1.75	1.80	1.75
24	1.50	1.40	1.45	1.20	1.75	2.70	1.40	2.05	2.05	1.75	1.85	1.75
25	1.55	1.35	1.45	1.25	1.75	2.65	1.40	2.05	2.05	1.80	1.85	1.75
26	1.60	1.35	1.40	1.25	1.80	2.60	1.45	2.05	2.10	1.80	1.85	1.75
27	1.55	1.35	1.40	1.25	1.80	2.50	1.45	2.00	2.10	1.70	1.85	1.75
28	1.50	1.40	1.40	1.30	1.80	2.45	1.40	2.00	2.10	1.70	1.85	1.70
29	1.50	.....	1.50	1.30	1.85	2.40	1.40	2.00	2.10	1.75	1.80	1.75
30	1.50	.....	1.50	1.30	1.85	2.40	1.45	2.00	2.10	1.75	1.80	1.70
31	1.50	.....	1.55	.....	1.90	.....	1.45	2.05	.....	1.70	.....	1.70

Daily gage height of Madison River at Red Bluff station, Montana, for 1894.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	1.70	.....	.....	1.65	1.65	.....	2.10	.....	.....	.....	1.70
2	.....	1.55	1.60	.....	.....	2.25	.....	1.50	1.55	1.65	.....
3	1.70	.....	.....	1.65	1.65	2.20	2.00	.....	.....	.....	1.70
4	.....	1.50	1.60	.....	.....	2.20	.....	1.50	1.50	1.60	.....
5	1.70	.....	.....	1.70	1.60	2.20	2.00	.....	.....	.....	1.70
6	.....	1.50	1.65	.....	.....	.....	.....	1.50	1.50	1.60	.....
7	1.75	.....	.....	1.70	1.65	2.30	1.90	.....	.....	.....	1.70
8	.....	1.50	1.65	.....	.....	.....	.....	1.50	1.50	1.50	.....
9	1.75	.....	.....	1.70	1.65	.....	1.90	.....	.....	.....	1.75
10	.....	1.50	1.65	.....	.....	2.30	.....	1.55	1.55	1.50	.....
11	1.80	.....	.....	1.75	1.65	.....	1.90	.....	.....	.....	1.75
12	.....	1.50	1.70	.....	.....	2.35	.....	1.50	1.60	1.50	.....
13	1.85	.....	.....	1.75	1.70	.....	1.95	.....	.....	.....	1.70
14	.....	1.55	1.75	.....	.....	2.30	.....	1.50	1.60	1.55	.....
15	1.85	.....	.....	1.70	1.75	.....	1.95	.....	.....	.....	1.70
16	.....	1.50	1.75	.....	.....	2.25	.....	1.50	1.65	1.60	.....
17	1.85	.....	.....	1.65	1.80	.....	1.90	.....	.....	.....	1.75
18	.....	1.60	1.75	.....	.....	2.20	.....	1.50	1.60	1.65	.....
19	1.80	.....	.....	1.65	1.80	.....	1.90	.....	.....	.....	1.70
20	.....	1.65	1.65	.....	.....	2.20	.....	1.50	1.65	1.65	.....
21	1.75	.....	.....	1.65	1.90	.....	1.80	.....	.....	.....	1.75
22	.....	1.65	1.70	.....	.....	2.15	.....	1.55	1.60	1.65	.....
23	1.70	.....	.....	1.75	1.95	.....	1.75	.....	.....	.....	1.75
24	.....	1.70	1.75	.....	.....	2.10	.....	1.50	1.60	1.70	.....
25	1.70	.....	.....	1.70	2.00	.....	1.70	.....	.....	.....	1.80
26	.....	1.70	1.70	.....	.....	2.10	.....	1.50	1.65	1.70	.....
27	1.65	.....	.....	1.70	2.10	.....	1.70	.....	.....	.....	1.85
28	.....	1.65	1.65	.....	.....	2.00	.....	1.45	1.70	1.70	.....
29	1.60	.....	.....	1.70	2.20	.....	1.65	.....	.....	.....	1.80
30	.....	.....	1.60	.....	.....	2.10	.....	1.45	1.70	1.70	.....
31	1.60	.....	.....	.....	2.20	.....	1.60	.....	.....	.....	.....

THREE FORKS STATION, ON MADISON RIVER.

This station was established August 24, 1893, by Mr. F. H. Newell, at the bridge of the Northern Pacific Railroad Company crossing Madison River about a half mile east of the railroad station of Three Forks. The gage was inclined, the zero being 14.11 feet below the top

of the rail on the east end of the bridge. When put in place the reading was 0.30, the measured discharge being 1,251 second-feet. Readings were begun on September 3, 1893, and continued throughout the year and until July 7, 1894, except during the months of January, February, and March, when the gage was obstructed by ice. Readings were again begun on October 21 by a new observer. On November 24 Mr. Arthur P. Davis inspected the station and made a gaging, the discharge being 1,494 second-feet for height of 0.57 foot. This locality is not favorable for obtaining the total discharge of Madison River, as a notable portion of the water finds an outlet through smaller channels crossing the low ground in various directions. At the time of the first measurement, that of August 24, 1893, 55 second-feet were discharging through various sloughs, and this amount should be added to the discharge as measured at the station. The drainage area, as measured from the Montana map, is 2,420 square miles.

Daily gage height of Madison River at Three Forks station, Montana, for 1893.

Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.
1..	.....	0.40	0.30	0.30	12....	0.20	0.40	0.20	0.10	23....	0.30	0.30	Ice.	.....
2...	.....	.30	.30	.30	13....	.20	.30	.20	.10	24....	.20	.30	Ice.	.....
3...	0.20	.30	.20	.10	14....	.20	.30	.20	.10	25....	.20	.30	Ice.	.....
4...	.20	.30	.20	.....	15....	.20	.30	.20	.20	26....	.20	.30	0.20	.....
5...	.20	.30	.20	.10	16....	.20	.30	.20	.20	27....	.20	.30	.30	.....
6...	.20	.30	.20	.10	17....	.20	.30	.20	.....	28....	.20	.30	.30	.....
7...	.20	.30	.20	.....	18....	.20	.30	.20	.....	29....	.30	.30	.30	.....
8...	.20	.30	.20	.....	19....	.20	.30	Ice.	.....	30....	.40	.30	.30	.....
9...	.20	.30	.20	.10	20....	.30	.30	.....	.....	31....	.....	.30	.....	.....
10...	.20	.30	.20	.10	21....	.30	.30	.20	.....					
11...	.20	.30	.20	.10	22....	.30	.30	.20	.....					

Daily gage height of Madison River at Three Forks station, Montana, for 1894.

Day.	Mar.	Apr.	May.	June.	July.	Oct.	Nov.	Dec.
1	.....	0.60	0.70	2.80	1.80	.....	0.50	0.50
2	.....	1.00	.70	2.80	1.70	.....	.50	.50
3	.....	.70	.60	2.80	1.60	.....	.50	.50
4	.....	.30	.50	2.80	1.60	.....	.50	.50
5	.....	.60	.50	2.70	1.60	.....	.50	.50
6	.....	.60	.60	2.70	1.60	.....	.50	.50
7	.....	.50	.60	2.70	1.60	.....	.50	.50
8	.....	.50	.80	2.70	.....	.....	.50	.50
9	.....	.50	1.00	2.60	.....	.....	.50	.50
10	.....	.50	1.00	2.40	.....	.....	.50	.50
11	.....	.50	1.00	2.20	.....	.....	.50	.50
12	.....	.40	1.00	2.00	.....	.....	.50	.50
13	.....	.10	1.20	1.80	.....	.....	.50	.50
14	.....	.20	1.40	1.80	.....	.....	.50	.50
15	.....	.30	1.60	1.70	.....	.....	.50	.50
16	.....	.30	1.80	1.60	.....	.....	.50	.50
17	*a* 2.20	.30	1.80	1.30	.....	.....	.50	2.80
18	.....	.30	1.80	1.20	.....	.....	.50	2.80
19	.....	.30	1.70	1.70	.....	.....	.50	1.60
20	.....	.30	1.70	1.70	.....	.....	.50	.50
21	.....	.40	1.80	1.70	.....	1.00	.50	.50
22	.....	.40	1.90	1.80	.....	1.00	.50	.50
23	.....	.60	2.00	1.80	.....	1.00	.50	.50
24	.....	.80	2.10	1.80	.....	1.00	.50	.50
25	.....	.80	2.20	1.80	.....	1.00	.50	.50
26	.....	.80	2.20	1.80	.....	1.00	.50	.50
27	.....	.80	2.40	1.80	.....	1.10	.50	.50
28	.70	.80	2.50	1.80	.....	.70	.50	.50
29	.50	.90	2.60	1.80	.....	.50	.50	.50
30	1.30	.70	2.70	1.80	.....	.50	.50	.75
31	1.00	.....	2.70	.....	.....	.50	.....	1.02

a No reading until March 17 on account of ice.

SAPPINGTON STATION, ON JEFFRSON RIVER.

The gage at this point is located under the northeast corner of the Northern Pacific Railroad bridge across Jefferson River, at Sappington. It was established November 13, 1894, by Mr. Arthur P. Davis. At that time the height of water was 1.08 feet. Observations of river height were begun on that date, but as the water froze around the gage during December, the later observations have relatively little value. The gage is partly inclined and partly vertical, the lower portion being graduated from 0.40 to 5 feet. The vertical portion is spiked to the bridge pier, and is graduated from 5 to 11 feet. Bench mark No. 1 is the head of a railroad spike driven into the top of the pile stump to which the lower end of the gage is spiked. It is 0.66 foot above the 1-foot mark of the gage. Bench mark No. 2 is the head of an 8-inch wire nail driven horizontally into the north end of the lower west cross timber of the east abutment. It is 7.76 feet above the 1-foot mark on the gage. Measurements are made by means of a cable stretched across the river 100 yards above the bridge. The channel is of coarse gravel, well adapted for measurements. A measurement made on November 14, 1894, showed a total discharge of 1,952 second-feet, the stream being 265 feet wide and having a mean depth of 2.76 feet; maximum depth, 3.40 feet; mean velocity, 2.67 feet per second; maximum velocity, 3.74 feet per second. The drainage area above this point is estimated to be 8,270 square miles.

A measurement of Jefferson River was made on August 24, 1893, when the water stood exactly 12 feet below the lower edge of the horizontal iron bars on the east end of the bridge near Three Forks. The discharge at that time was 808 second-feet. The section, however, is not favorable for measurement, owing to the dead water in the broad, obstructed channel, and no station was established until November 13, 1894, when, after a search along the river, the above-described location at Sappington was chosen, 15 miles west of Three Forks.

TOWNSEND STATION, ON MISSOURI RIVER.

This station was established in 1891 by the Missouri River Commission, and readings have been made continuously since that time by an observer employed by the Commission. The locality is 2,504 miles above the mouth of the river. The following description of the gage, its location, and bench marks is from Lieut. J. C. Sanford, secretary of the Missouri River Commission:

> A standard wire cable gage was erected by the Missouri River Commission October 1, 1891, on a county road bridge, located about 300 feet below the Northern Pacific Railroad bridge across the Missouri River near Townsend, Mont. Its zero is set at an approximate elevation of 3,700 feet above sea level as determined from a primary line of levels, run under the direction of the Commission in 1890, from Three Forks to Fort Benton, Mont., and starting from a bench mark of the Northern Pacific Railroad at Gallatin, Mont. (See Annual Report of Chief of Engineers, 1891.)

Reference bench mark is B. M. 10 (Townsend), described as "located on the right bank of the Missouri River, about one-half mile north of Townsend Railroad station, about one-half mile from river measured in a perpendicular direction to track, and about three-quarters mile south of railroad bridge over the Missouri River. It is about 60 feet west of a point on the track, 30 feet north of railroad bridge No. 392, and about 7 feet west of railroad fence. Compass reading to milepost 1121 is 318°. Marked by stone and pipe; elevation, 3,795.991 feet. This elevation is erroneous, but is the elevation from which the gage is set.

The tabulated records of the Townsend gage are reductions to the St. Louis directrix datum obtained by subtracting 400.063 feet from the daily means of the gage readings. The gage reads from 3,785 to 3,799 feet.

Lieutenant Sanford states that since the establishment of the gage level lines have been completed connecting all of the upper river gages with the datum of the Missouri River Commission. Precise levels have been run up to Sioux City, Iowa, and above that checked Y lines have been run under the direction of Capt. H. F. Hodges, Corps of Engineers, United States Army, and of the Missouri River Commission. The elevations of the zeros of the other Montana gages read during 1890 are as follows:

Elevations of river gages in Montana.

Locality.	Above mouth.	Elevation of gage zero.
	Miles.	*Feet.*
Great Falls	2,333.3	2,897.165
Craig	2,415.7	3,028.575
Stubbs Ferry	2,463.8	3,207.674
Toston	2,519.8	3,477.230
Gallahers Ferry	2,546.4	3,613.069
Gallatin Ferry	2,546.7	3,614.783

Measurements of discharge at this point were made on August 25, 1893, by Mr. F. H. Newell, when for a gage height of 3,788.75 feet there was found to be a discharge of 3,008 second-feet. The volumes of the three large rivers forming the Missouri, as measured during preceding days, were as follows: Jefferson, 808 second-feet; Madison, 1,251 second-feet; West Gallatin, 818 second-feet; various sloughs, 55 second-feet; making an aggregate of 2,932 second-feet. A second measurement, made November 18, 1894, by Mr. Arthur P. Davis, showed for a height of water of 3,789 feet on the gage a discharge of 3,766 second-feet. The total width of the stream was 425 feet; the mean depth, 3.63 feet; the maximum, 7.50 feet; the mean velocity, 2.44 feet; the maximum velocity 4.68 feet. The stream is divided into four channels by the three bridge piers; otherwise the conditions are favorable for accurate measurement.

These quantities above given represent the discharge for the greater part of the last half of the year, the water rarely falling below 3,788.5. The area drained at this point is approximately 15,000 square miles, comprising, as above stated, the inflow from the Gallatin, the Madison, and the Jefferson rivers. This gage at Townsend is the highest of a

series of twenty or more gages maintained permanently by the Missouri River Commission. Descriptions of these gages are given in the annual report of the Missouri River Commission, contained in the Annual Report of the Chief of Engineers, United States Army; that for 1891, on page 3819; for 1892, on page 3271, and for 1893, on page 2316. The distance of this point above Sioux City is 1,703 miles, and above Fort Benton, the next gage below maintained by the Corps of Engineers, 219 miles. In the report of the Chief of Engineers, United States Army, for 1893, page 2320, it is stated that there is under way an "examination of Missouri River from Three Forks to Canyon Ferry, Mont., with a view of determining at what points, if any, use might be made of water power for manufacturing and other purposes without unreasonably impairing the navigability. This part of the river was surveyed and mapped in 1890 under the direction of the Missouri River Commission. For the present work it is proposed to examine the maps of this survey and select such points as seem suitable to personally examine the localities, and by additional field work to get the necessary data for a report."

The gaging station on the upper Missouri River in the vicinity of Craig, referred to in previous reports, was abandoned in June, 1892, owing to the expense of maintenance and the fact that the Missouri River Commission had a gage at Townsend, Mont.

Daily gage height of Missouri River at Townsend station, Montana, for 1891.

Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.
1....	88.3	88.5	88.6	12.....	88.5	88.5	88.2	23.....	88.5	88.7	88.4
2....	88.3	88.5	88.6	13.....	88.5	88.4	88.3	24.....	88.6	88.5	*a* 89.7
3....	88.4	88.5	88.6	14.....	88.6	88.4	88.4	25.....	88.6	88.6	89.7
4....	88.4	88.5	88.5	15.....	88.6	88.3	88.4	26.....	88.6	88.7	89.7
5....	88.4	88.5	88.4	16.....	88.6	88.2	88.4	27.....	88.6	88.7	89.7
6....	88.4	88.6	88.2	17.....	88.6	88.2	88.4	28.....	88.6	88.7	90.2
7....	88.4	88.6	88.2	18.....	88.6	88.2	88.4	29.....	88.5	88.6	90.4
8....	88.5	88.6	88.2	19.....	88.6	88.5	88.4	30.....	88.5	88.6	90.4
9....	88.5	88.5	88.2	20.....	88.6	88.9	88.6	31.....	88.5	.....	90.6
10....	88.5	88.5	88.2	21.....	88.5	89	88.6				
11....	88.5	88.5	88.2	22.....	88.5	89	88.5				

a Ice readings after December 24.

Daily gage height of Missouri River at Townsend station, Montana, for 1892.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1.....	*a* 90.7	90.6	88.6	88.5	88.7	92.6	94.1	88.9	88.5	88.4	88.7	88.7
2.....	90.7	90.6	88 6	88.5	88.7	92.3	93.9	88.8	88.5	88.4	88.7	88.8
3.....	90.7	90.6	88.6	88.5	88.7	92.2	93.7	88.8	88.5	88.6	88.7	88.8
4.....	90.7	90.6	88.6	88.5	88.7	92.0	93.6	88.7	88.5	88.5	88.7	88.8
5.....	90.7	90.6	88.6	88.5	88.7	91.8	93.2	88.7	88.5	88.5	88.7	88.7
6.....	90.6	90.6	88.6	88.4	88.7	91.6	92.9	88.7	88.5	88.5	88.7	88.6
7.....	90.6	90.6	88.7	88.4	88.7	91.6	92.8	88.7	88.5	88.5	88.7	88.4
8.....	90.6	90.6	88.7	88.4	88.7	92.0	92.6	88.7	88.5	88.4	88.7	88.3
9.....	90.5	90.6	88.7	88.4	88.7	92.2	92.4	88.7	88.4	88.4	88.7	88.3
10.....	90.5	90.6	88.6	88.4	88.8	92.6	92.0	88.7	88.4	88.5	88.7	88.2
11.....	90.4	90.6	88.6	88.5	89.0	93.0	91.8	88.7	88.4	88.6	88.7	88.2
12.....	90.2	90.6	88.6	88.6	89.0	93.5	91.7	88.7	88.4	88.6	88.7	88.2
13.....	90.1	90.6	88.7	88.6	89.1	93.6	91.6	88.7	88.3	88.7	88.7	88.2
14.....	90.1	90.6	88.7	88.7	89.2	93.6	91.4	88.7	88.3	88.7	88.7	88.2
15.....	90.3	90.7	88.7	88.7	89.4	93.6	91.1	88.7	88.3	88.7	88.7	88.3
16.....	90.4	90.7	88.6	88.7	89.5	93.6	91.0	88.6	88.3	88.7	88.7	88.4
17.....	90.4	90.8	88.6	88.7	89.6	93.7	90.7	88.5	88.3	88.7	88.7	88.6
18.....	90.4	90.8	88.6	88.8	89.8	93.8	90.5	88.4	88.3	88.7	88 7	88.6
19.....	90.4	90.8	88.6	88.8	90.1	94.2	90.2	88.4	88.3	88.7	88.7	88.7
20.....	90.4	90.8	88.6	88.8	90.2	94.7	90.0	88.4	88.3	88.7	88.7	88.8
21.....	90.4	90.8	88.6	88.7	90.2	95.0	89.9	88.4	88.3	88.7	88.7	89.6
22.....	90.4	90.7	88.6	88.7	90.4	95.1	89.7	88.4	88.4	88.7	88.7	*b* 90.4
23.....	90.4	90.7	88.6	88.7	90.5	95.0	89.7	88.4	88.4	88.7	88.8	90.4
24.....	90.4	89.9	88.6	88.6	91.0	94.7	89.5	88.4	88.4	88.7	88.8	90.4
25.....	90.5	88.7	88.5	88.6	91.4	94.4	89.4	88.4	88.3	88.7	88.8	90.4
26.....	90.5	88.6	88.5	88.7	91.8	94.2	89.3	88.5	88.3	88.7	88.6	90.4
27.....	90.6	88.5	88.5	88.7	92.3	94.1	89.2	88.5	88.3	88.7	88.6	90.4
28.....	90.6	88.6	88.5	88.7	92.6	93.8	89.1	88.5	88.4	88.7	88.4	90.5
29.....	90.6	88.6	88.5	88.7	93.0	93.7	89.1	88.5	88.4	88.7	88.4	90.5
30.....	90.6	.....	88.5	88.7	92.8	94.4	89.0	88.5	88.4	88.7	88.6	90.7
31.....	90.6	.....	88.5	.....	92.7	.....	88.9	88.5	.....	88.7	.....	90.7

a Ice readings to February 23. *b* Ice readings after December 22.

Daily gage height of Missouri River at Townsend station, Montana, for 1893.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1.....	*a* 90.8	91.2	91.3	90.0	89.0	91.0	91.2	89.0	88.5	89.1	89.0	88.8
2.....	91.0	91.2	91.3	89.6	89.0	91.1	91 1	89.0	88.4	89.1	89.0	88.8
3.....	91.2	91.2	91.3	89.5	89.2	91.2	91.1	88.9	88.4	89.1	89.0	88.8
4.....	91.4	91.2	91.3	89.4	89.2	91.4	91 0	88.8	88.4	89.1	89.0	88.8
5.....	91.4	31.2	91.5	89.2	89.3	91.4	91.0	88.8	88.4	89.1	89.0	88.8
6.....	91.4	91.3	91.5	89.2	89.3	91.4	90.9	88.7	88.4	89.0	89.0	88.8
7.....	91.4	91.4	91.6	89.1	89.3	91.4	90.9	88.7	88.4	89.0	89.0	88.8
8.....	91.4	91.4	91.6	89.1	89.5	91.8	90.6	88 6	88.6	89.0	89.0	88.8
9.....	91.4	91.5	91.7	89.1	89.7	92.2	90 5	88.6	88.6	89.0	89.0	88.8
10.....	91.4	91.5	91.8	89.1	90.1	92.5	90.3	88.5	88.5	89.0	89.0	88.8
11.....	91.4	91.5	91.9	89.0	90.2	92.9	90.3	88.5	88.6	89.0	89.0	88.8
12.....	91.4	91.5	92.0	88.8	90.4	93.4	90.2	88.5	88.6	89.0	89.0	88.7
13.....	91.4	91.5	92.0	88.7	90.4	94.1	90.2	88.5	88.6	89.0	89.0	88.7
14.....	91.4	91.5	92.0	88.7	90.7	94.5	90.2	88.5	88.6	89.0	89.0	88.7
15.....	91.4	91.5	92.0	88.7	90.9	94.4	90.1	88.5	88.6	89.0	88.8	88.7
16.....	91.4	91.5	92.0	88.7	91.4	93.9	90.0	88.5	88.6	89.0	88.6	88.7
17.....	91.4	91.5	92.0	88.6	91.6	93.7	89.8	88.5	88.6	89.0	88.5	88.7
18.....	91.4	91.5	92.0	88.6	92.4	93.4	89.7	88.5	88.6	89.0	88.5	88.7
19.....	91.5	91.5	92.0	88.6	92.7	93.4	89.6	88.5	88.7	89.0	88.5	88.7
20.....	91.5	91.5	92.0	88.6	92.5	93.5	89.5	88.5	88.7	89.0	88.5	88.7
21.....	91.5	91.5	88.8	88.6	92.3	93.2	89.5	88.5	88.8	89.0	88.6	88.7
22.....	91.5	91.5	88.6	88.6	92.0	93.0	89.4	88.5	88.8	89.0	88.6	88.7
23	91.5	91.5	88.6	88.6	91.9	92.7	89.2	88.6	88.8	89.0	88.6	88.6
24.....	91.5	91.5	88.7	88.6	91.7	92.5	89.2	88.6	88.8	89.0	88.7	88.6
25.....	91.4	91.5	88.8	88.7	91.5	92.5	89.2	88.7	88.8	89.0	88.8	88.5
26.....	91.4	91.5	88.8	88.7	91.1	92.4	89.2	88.6	88.8	89.0	88.8	88.5
27.....	91.4	91.4	89.1	88.8	90.9	92.2	89.1	88.6	88.9	89.0	88.8	88.5
28.....	91.4	91.3	89.3	88.9	90.8	92.0	89.1	88.6	89.1	89.0	88.8	88.4
29.....	91.4	.....	89.7	89.0	90.5	91.8	89.0	88.6	89.1	89.0	88.8	88.3
30.....	91.3	.....	89.8	89.0	90.6	91.4	89 0	88.5	89.1	89.0	88.6	88.4
31.....	91.3	.....	89.8	.....	90.8	.....	89.0	88.5	.....	89.0	.....	88.5

a Ice readings to March 20.

Daily gage height of Missouri River at Townsend station, Montana, for 1894.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	88.4	91.0	91.0	89.7	91.2	95.4	92.4	89.5	88.8	89.0	89.1	89.0
2	88.4	91.0	91.0	89.6	91.1	95.5	92.3	89.4	88.8	89.1	89.1	88.9
3	88.6	91.0	91.0	89.7	91.0	95.7	92.2	89.4	88.8	89.1	89.1	88.8
4	90.1	91.0	91.0	89.7	90.7	95.7	92.2	89.4	88.8	89.1	89.1	88.8
5	*a*91.4	91.0	91.0	89.7	90.5	95.7	92.2	89.4	88.7	89.0	89.1	88.7
6	91.4	91.0	91.0	89.7	90.6	95.6	92.1	89.4	88.9	89.0	89.1	88.8
7	91.4	91.0	91.0	89.7	90.7	95.6	92.0	89.4	89.0	89.1	89.1	88.8
8	91.5	91.0	91.0	89.6	90.9	95.5	91.9	89.4	89.1	89.1	89.0	88.8
9	91.6	91.0	91.0	89.5	91.2	95.4	91.7	89.4	89.0	89.1	89.0	88.7
10	91.9	91.0	91.0	89.7	91.3	95.1	91.6	89.4	89.0	89.1	89.0	88.7
11	92.2	91.0	91.0	89.7	91.5	94.8	91.4	89.4	89.0	89.1	89.0	88.7
12	92.2	91.0	91.2	89.7	91.7	94.5	91.4	89.4	89.0	89.1	89.1	88.7
13	92.2	91.0	91.3	89.7	91.7	93.9	91.5	89.4	89.0	89.1	89.1	88.6
14	92.2	91.0	91.6	89.7	91.7	93.6	91.4	89.3	89.0	89.1	89.1	88.5
15	92.1	91.0	91.9	89.7	92.1	93.2	91.2	89.2	89.0	89.1	89.1	88.5
16	91.8	91.0	92.2	89.6	92.8	92.8	91.0	89.2	89.0	89.1	89.0	88.6
17	91.7	91.0	92.4	89.5	92.9	92.6	90.9	89.1	89.0	89.1	89.0	88.6
18	91.5	91.0	92.4	89.4	92.8	92.6	90.7	89.1	89.0	89.1	88.9	88.7
19	91.4	90.4	92.4	89.6	92.8	92.7	90.7	89.1	89.0	89.1	89.0	88.7
20	91.4	90.6	92.4	89.7	92.9	92.8	90.5	89.1	89.0	89.1	89.0	88.7
21	91.3	90.4	91.2	89.8	93.2	92.7	90.4	89.1	89.0	89.1	89.0	88.8
22	91.2	90.4	89.5	90.1	93.6	92.6	90.2	89.0	89.0	89.1	89.0	88.8
23	91.0	90.4	89.5	90.6	93.8	92.7	90.1	89.0	88.9	89.1	89.0	88.8
24	91.0	90.4	89.7	91.2	94.2	92.7	89.9	88.9	88.9	89.1	89.0	88.8
25	91.0	90.4	89.7	91.7	94.2	92.7	89.8	88.8	88.9	89.1	89.0	88.8
26	91.0	90.5	89.7	91.8	94.4	92.7	89.8	88.8	88.9	89.1	89.0	88.8
27	91.0	90.7	89.7	92.0	94.6	92.7	89.8	88.8	88.9	89.1	89.0	*b*89.3
28	91.0	90.8	89.7	92.0	94.7	92.7	89.9	88.8	88.9	89.1	89.0	89.3
29	91.0	.....	89.7	91.7	95.0	92.5	89.9	88.8	88.9	89.1	89.0	89.3
30	91.0	.....	89.7	91.5	95.1	92.4	89.7	88.8	89.0	89.1	89.0	89.3
31	91.0	.....	89.7	.....	95.3	.....	89.6	88.8	.....	89.2	.....	89.8

a Ice readings from January 5 to March 21. *b* Ice readings after December 27.

YELLOWSTONE BASIN, IN WYOMING AND MONTANA.

The river stations upon the Yellowstone, maintained for a number of years at points below Yellowstone National Park, have been abandoned, owing to expense of maintenance and difficulty of access. Measurements of tributaries in Wyoming have been made by Prof. Elwood Mead, State engineer, and by others, the results being shown in the list of gagings on pages 29, 31.

HORR STATION, ON YELLOWSTONE RIVER, MONTANA.

This locality was chosen on August 12, 1889, by Mr. J. B. Williams, at Bowers Ferry, near the small town of Horr, on the Park Branch of the Northern Pacific Railroad. The section is well adapted for discharge measurements, the river being of nearly uniform width above and below the station, and with moderately high banks over which the river does not flow in high water. The bed is composed of coarse gravel and small bowlders, and is not liable to change in ordinary floods. Readings were continued at this point until November 30, 1889, when, on account of the change of the position of the ferry, a new locality one-fourth of a mile farther downstream was selected. At this second point the river is 150 feet wide.

The gage is inclined and securely fastened by braces. It is about 60 feet long, with nearly uniform inclination at an angle of 12° to the horizontal. The bench mark is on the stump of a tree 10 inches in

diameter, sawed off about 3 feet above the ground, marked "B. M." on top. It is very nearly in line with the extended cross section on the right bank of the river, and about 50 feet above the upper end of the gage. The elevation of the bench mark above zero is 11.55 feet. Observations at this point were continued until November 4, 1893, except at times when ice in the river prevented accurate readings. From the discharge measurements made during 1890 and 1891 a rating table was constructed which is probably applicable to these readings for 1893, and is therefore given below:

Rating table for Yellowstone River at Horr station, Montana.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
	Sec. feet.		*Sec. feet.*		*Sec. feet.*		*Sec. feet.*
1.00	650	3.00	2,890	5.00	6,270	7.00	9,760
1.10	710	3.10	3,060	5.10	6,440	7.10	9,930
1.20	780	3.20	3,230	5.20	6,600	7.20	10,110
1.30	850	3.30	3,400	5.30	6,770	7.30	10,290
1.40	920	3.40	3,570	5.40	6,940	7.40	10,460
1.50	1,000	3.50	3,740	5.50	7,110	7.50	10,640
1.60	1,080	3.60	3,910	5.60	7,290	7.60	10,810
1.70	1,160	3.70	4,080	5.70	7,480	7.70	10,980
1.80	1,250	3.80	4,240	5.80	7,660	7.80	11,150
1.90	1,340	3.90	4,410	5.90	7,840	7.90	11,320
2.00	1,440	4.00	4,580	6.00	8,010	8.00	11,490
2.10	1,550	4.10	4,750	6.10	8,190	8.10	11,660
2.20	1,670	4.20	4,920	6.20	8,360	8.20	11,830
2.30	1,790	4.30	5,090	6.30	8,540	8.30	12,000
2.40	1,920	4.40	5,260	6.40	8,720	8.40	12,170
2.50	2,060	4.50	5,430	6.50	8,890	8.50	12,340
2.60	2,210	4.60	5,600	6.60	9,060	8.60	12,520
2.70	2,370	4.70	5,760	6.70	9,230	8.70	12,690
2.80	2,540	4.80	5.930	6.80	9,410	8.80	12,860
2.90	2,720	4.90	6,100	6.90	9,590	8.90	13,040

Daily gauge height of Yellowstone River at Horr station, Montana, for 1893.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	.....	1.00	4.35	6.75	4.45	2.65	2.40	2.00
2	.....	1.10	4.50	6.85	4.35	2.60	2.45	2.00
3	.....	1.20	4.50	6.90	4.25	2.50	2.50	2.00
4	.....	1.20	4.30	6.90	4.15	2.40	2.45	2.00
5	.....	1.15	4.35	6.55	4.10	2.45	2.40	.....
6	.....	1.20	4.95	6.40	4.05	2.55	2.35	.....
7	.....	1.30	5.55	6.20	3.95	2.60	2.30	.....
8	.....	1.40	6.60	6.10	3.90	2.70	2.25	.....
9	.....	1.85	6.75	6.10	3.85	2.80	2.20	.....
10	.....	2.25	7.60	6.20	3.80	2.75	2.15	.....
11	.....	2.10	8.50	6.25	3.75	2.65	2.20	.....
12	.....	2.50	9.10	5.90	3.70	2.60	2.15	.....
13	.....	3.30	9.20	5.85	3.60	2.55	2.20	.....
14	.....	3.75	7.50	5.80	3.55	2.50	2.10	.....
15	.....	4.35	7.00	5.75	3.45	2.50	2.15	.....
16	1.10	4.80	7.50	5.60	3.35	2.50	2.10	.....
17	.95	5.80	7.90	5.50	3.30	2.50	2.10	.....
18	1.10	6.35	8.50	5.50	3.30	2.50	2.15	.....
19	1.15	5.20	8.40	5.40	3.35	2.40	2.10	.....
20	1.10	4.25	8.20	5.30	3.30	2.50	2.10	.....
21	.90	4.00	7.40	5.30	3.30	2.60	2.10	.....
22	.90	3.80	7.45	5.20	3.30	2.50	2.00	.....
23	1.10	3.75	7.40	5.10	3.30	2.50	2.00	.....
24	1.10	3.50	7.15	4.95	3.25	2.40	2.10	.....
25	1.15	3.45	7.25	4.90	3.15	2.40	2.00	.....
26	1.10	3.25	7.30	4.70	3.05	2.35	2.00	.....
27	.90	3.10	7.20	4.60	3.00	2.40	2.00	.....
28	.90	3.20	7.15	4.75	2.95	2.50	2.00	.....
29	.95	3.55	7.00	4.65	2.90	2.40	2.00	.....
30	.95	3.80	6.80	4.65	2.85	2.40	2.00	.....
31	.....	3.90	.....	4.50	2.75	.....	2.00	.....

PLATTE BASIN, IN WYOMING, COLORADO, AND NEBRASKA.

This basin has been described quite fully in the Thirteenth Annual Report of the Survey, Part III, Irrigation, pages 73–91. Measurements have been made on the headwaters of this river, mainly by Prof. Elwood Mead, State engineer of Wyoming; and in Colorado, by the State engineer, and by Prof. L. G. Carpenter, meteorologist and irrigation engineer of the State experiment station at the State Agricultural College. In 1894 work was begun in Nebraska by cooperation with Mr. O. V. P. Stout, professor of civil engineering at the University of Nebraska, and a number of stations were established, as shown by the following descriptions.

WOODS LANDING STATION, ON LARAMIE RIVER, WYOMING.

The station at Woods Landing was established in December, 1888, by Prof. Elwood Mead, observations being continued during the months from April to September, inclusive, in 1889, 1890, and 1891.[1] Below this point a large number of ditches divert the water of Laramie River, so that during the irrigating season very little crosses the Laramie plains or reaches Laramie. The report of the State engineer shows that fifty-three ditches have filed claims to water, the total area described as under these ditches being 150,000 acres. A few measurements have been made of the amount of water passing Laramie. One of these on September 27, 1894, gave 27 second-feet. Beyond this point the river flows in a northerly direction for about 50 miles, and then turns easterly through the Laramie Hills. Near this point are the head works of the Wyoming Development Company's irrigation system, which divert water by means of a stone dam. The canal heading at this point passes through a tunnel 3,100 feet in length, and finally empties into Bluegrass and Sybille creeks, whence the water is again diverted for use in the vicinity of Wheatland. The amount of water which passes this stone dam or returns below to the river by seepage has been measured at the railroad crossing at Uva.

UVA STATION, ON LARAMIE RIVER, WYOMING.

Measurements of river flow were made at the railroad crossing at Uva, Wyo., on June 6, 1894, showing a discharge of 1,845 second-feet, and again on October 24, 1894, giving only 14 second-feet. At about this latter date a gage rod was established at this point and observations were begun. The gage is vertical, and is nailed to the center pier of the railroad bridge at Uva. At a distance of about 25 miles below this

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[1]See Twelfth Annual Report United States Geological Survey, Part II, Irrigation, p. 239; Thirteenth Annual Report United States Geological Survey, Part III, Irrigation, pp. 79 and 80; First Biennial Report of the State Engineer to the Governor of Wyoming, 1891 and 1892, Cheyenne, Wyo., 1892, Appendix, pp. xviii and xx; Second Biennial Report of the State Engineer to the Governor of Wyoming, 1893 and 1894, Cheyenne, Wyo., 1894, p. 135.

point Laramie River discharges into the North Platte, Fort Laramie being situated at the junction. Here a float measurement on August 20, 1894, showed a discharge of 51 second-feet, and on October 7, 1894, 23 second-feet.

DOUGLAS STATION, ON NORTH PLATTE RIVER, WYOMING.

Results of occasional measurements of the higher tributaries of North Platte River are given in the Thirteenth Annual Report of the United States Geological Survey, Part III, Irrigation, page 78. The highest permanent station, however, is at Douglas, Wyo., established by the State engineer in 1891. Above this place, on the north side of the river, are extensive tracts of land which can possibly be reclaimed, though at heavy expense, by canals heading 70 miles or more west of Douglas. Records at Douglas have been kept for portions of four years. The results for 1894, as computed by the State engineer of Wyoming, are shown in the following table:

Daily gage height and discharge of North Platte River at Douglas Station, Wyo., for 1894.

Day.	May.		June.		July.		August.		September.	
	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
		Sec. feet.		*Sec. feet.*		*Sec. feet.*		*Sec. feet.*		*Sec. feet.*
1	7.8	4,600	10 3	11,052	7.7	4,380	5.8	1,000	5.2	790
2	7.8	4,600	10.5	11,668	7.6	4,157	5.8	1,000	5.2	790
3	8.0	5,044	10.6	11,977	7.4	3,718	5.8	1,000	5.2	790
4	8.2	5,488	10.8	12,596	7.3	3,500	5.7	960	5.2	790
5	8.3	5,710	10.9	12,907	7.3	3,500	5.7	960	5.2	790
6	8.6	6,377	10.8	12,596	7.6	4,157	5.6	920	5.1	765
7	8.6	6,377	10.8	12,596	7.6	4,157	5.6	920	5.1	765
8	8.8	6,823	10.9	12,907	7.6	4,157	5.6	920	5.1	765
9	8.9	7,076	11.0	13,218	7.5	3,937	5.8	1,000	5.1	765
10	9.3	8,092	10.8	12,596	7.3	3,500	5.7	960	5.1	765
11	9.4	8,346	10.5	11,668	7.2	3,283	5.6	920	5.2	790
12	9.7	9,212	10.0	10,131	7.0	2,850	5.6	920	5.2	790
13	10.0	10,131	9.5	8,600	7.0	2,850	5.5	883	5.1	765
14	10.0	10,131	9.1	7,584	6.8	2,423	5.4	850	5.2	790
15	10.0	10,131	9.1	7,584	6.8	2,423	5.3	815	5.4	850
16	10.1	10,438	9.0	7,330	6.7	2,211	5.5	883	5.4	850
17	10.3	11,052	9.1	7,584	6.6	2,000	5.5	883	5.4	850
18	10.5	11,668	9.1	7,584	6.6	2,000	5.4	850	5.3	815
19	10.3	11,052	9.0	7,330	6.7	2,211	5.4	850	5.3	815
20	10.0	10,131	8.8	6,823	6.7	2,211	5.4	850	5.3	815
21	9.7	9,212	8.7	6,600	6.7	2,211	5.4	850	5.2	790
22	9.6	8,906	8.5	6,154	6.7	2,211	5.3	815	5.2	790
23	9.8	9,518	8.4	5,932	6.7	2,211	5.3	815	5.2	790
24	9.9	9,824	8.3	5,710	6.6	2,000	5.3	815	5.2	790
25	9.9	9,824	8.2	5,488	6.4	1,620	5.3	815	5.2	790
26	9.8	9,518	8.0	5,044	6.2	1,345	5.3	815	5.2	790
27	9.8	9,518	8.0	5,044	6.2	1,345	5.3	815	5.1	765
28	9.8	9,518	7.9	4,822	6.2	1,345	5.3	815	5.1	765
29	9.8	9,518	7.8	4,600	6.0	1,145	5.2	790	5.2	790
30	10.0	10,131	7.7	4,380	5.9	1,070	5.2	790	5.2	790
31	10.2	10,745	.....	.....	5.8	1,000	5.2	790	.....	.....

ORIN STATION, ON NORTH PLATTE RIVER.

About 25 miles below Douglas the North Platte River is crossed by the Cheyenne and Northern Railroad, which joins the Fremont, Elkhorn and Missouri Valley Railroad at Orin Junction. At this railroad bridge a number of measurements have been made, and observations of river height were begun on November 1, 1894. The gage at this

point is vertical, and is nailed to the central pier of the railroad bridge. A measurement on May 8, 1894, gave a discharge of 6,823 second-feet; one on June. 7, 12,596 second-feet, and one on August 15, only 816. second-feet. Below this point the river continues for many miles in a narrow canyon, in which it receives little water from lateral streams.

Near Fort Laramie a float gaging made by Mr. John Hunton, November 7, 1894, gave a computed discharge of 636 second-feet. From Fort Laramie east to the Nebraska line comparatively little water is diverted from the river. However, favorable conditions are reported[1] for taking out water to cover the lands along the river, especially on the south side, to the relatively low area known as "Goshen Hole." The altitude here is less than that of any other valley in the State, excepting in the extreme northern part, east of Big Horn range, near the Montana line.

In the extreme eastern part of Wyoming and in western Nebraska a considerable amount of water is delivered from the North Platte River for irrigation, as mentioned in a preceding report.[2] The area of land under these canals is being extended year by year, and the settlement of the country is progressing rapidly. Measurements of the river have been made at various points, but no permanent station has been established above the town of North Platte, which is at the junction of this river with the South Platte. Measurements at Camp Clarke have been given in preceding reports. A float measurement on July 26, 1894, gave an approximate discharge of 1,900 second-feet, and one at Gering on July 28, 1894, about 2,500 second-feet. On October 11, 1894, a gaging at the river bridge, almost due north from the town of Ogallala, showed a discharge of 609 second-feet.

NORTH PLATTE STATION, ON NORTH PLATTE RIVER, NEBRASKA.

A gaging station was established at North Platte and readings of river height were begun in the winter of 1894–95. A measurement on October 5, 1894, at the wagon bridge north of town gave a total discharge of 620 second-feet. A second measurement on November 6 at the same point gave 1,227 second-feet. Both of these were made by Mr. Charles P. Ross by means of electric current meters.

FORT COLLINS STATION, ON CACHE LA POUDRE RIVER, COLORADO.

One of the longest records, and probably the best of any small stream in the West, is that being maintained on the Cache la Poudre at a point about 15 miles above Fort Collins. This station was established in 1888 by Prof. L. G. Carpenter, meteorologist and irrigation engineer at the Colorado State Agricultural College. The work has been carried on under the immediate direction of Professor Carpenter, who has done everything in his power to make the results accurate and

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[1] Elwood Mead, Biennial Report of State Engineer, 1894, p. 131.

[2] Thirteenth Annual Report United States Geological Survey, Part III, Irrigation, p. 81.

of scientific value. Various forms of self-recording nilometer have been used at this point, and an apparatus has finally been installed by which the height of water at the river station is recorded by electrical devices at the Agricultural College at Fort Collins. The results of computations of daily discharge for 1893 and 1894, as published in the annual report of the State engineer, are given in the following table.

Besides the computations of daily discharge at this point, a series of measurements have been made along Cache la Poudre Creek and South Platte River to determine the amount of water taken from these streams and the quantity flowing in the channel at various points, and as a result the amount which enters the river by means of percolation or seepage. The results obtained are of the highest value, showing, as they do, that these streams, and inferentially others of this class, receive large quantities of water during and after the irrigating season by the soaking of the ground and a gradual return to the drainage lines.

Daily mean discharge of Cache la Poudre River for 1893 and 1894.

[Second-feet.]

	1893.				1894.						
Day.	May.	June.	July.	Aug.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	.....	.....	1,144	336	.....	2,652	1,109	479	171	144	79
2	.....	.....	1,038	343	492	2,820	1,082	494	182	158	91
3	.....	.....	996	321	481	3,046	1,109	512	178	135	96
4	.....	1.230	997	282	483	3,206	1,273	440	179	141	.....
5	.....	1,108	947	256	572	3,461	1,234	379	161	118	.....
6	.....	1,041	795	251	663	3,672	1,158	396	152	146	.....
7	.....	1,197	840	251	793	3,514	1,078	513	140	151	91
8	.....	1,767	833	293	1,057	2,782	956	487	227	143	95
9	.....	2,198	744	327	1,299	2,094	925	477	296	128	96
10	.....	2,667	693	298	1,208	1,908	925	464	281	131	93
11	217	2,912	663	.....	1,246	2,067	923	427	276	120	89
12	344	2,949	678	.....	1,321	2,236	936	393	246	107	94
13	278	2,252	661	.....	1,453	2,346	1,177	362	219	99	85
14	308	.....	602	.....	1,538	2,291	878	365	178	94	80
15	.....	.....	608	.....	1,829	2,104	982	369	165	93	85
16	.....	.....	576	.....	1,838	2,027	899	347	155	93	77
17	.....	.....	526	.....	1,355	1,791	782	319	157	93	42
18	.....	2,386	511	.....	1,315	1,915	817	298	152	93	116
19	.....	2,483	476	239	1,697	1,717	820	295	146	89	150
20	.....	2,427	454	189	1,842	1,586	728	282	135	97	146
21	1,047	2,274	401	226	2,051	1,452	696	278	118	82	115
22	1,043	1,905	384	218	1,779	1,458	647	271	113	85	107
23	920	1,758	359	248	1,585	1,427	602	274	108	87	*b* 60
24	841	1,616	348	219	1,302	1,375	567	240	105	84	*b* 57
25	870	1,422	353	191	1,483	1,250	561	229	108	84	103
26	974	1,354	444	161	*a* 1,650	1,216	567	212	107	84	90
27	876	1,246	463	155	1,817	1,228	553	204	101	78	92
28	812	1,244	406	158	1,984	1,120	522	179	99	74	91
29	878	1,177	383	158	2,151	1,065	497	182	132	71	89
30	1,107	1,132	354	141	2,318	1,067	461	165	145	71	93
31	929	.....	343	151	2,485	.....	444	162	.....	78	.....

a Interpolated from May 26 to June 1.

b Float stopped by ice.

The lower South Platte in its course through northeastern Colorado is utilized to such an extent for irrigation that the channel becomes dry during the great part of the year. No measurements as yet have been made of the quantity flowing into Nebraska. The sandy channel and lowlands adjacent to this are saturated with water, and although it may not be feasible to bring this out by gravity methods for supply-

ing irrigating ditches, yet it has been demonstrated to be possible to pump what appears to be practically an inexhaustible supply.

The main Platte River, formed by the junction of the North and South branches, flows easterly through Nebraska, only a small proportion of its water being diverted for irrigation and water power. The channel is extremely wide, and during the hotter part of the summer the water is divided and subdivided into numerous small rivulets in the broad, sandy plain. Many of these gradually disappear by evaporation or by percolation into the sands, and thus at points along the river the channel is sometimes almost completely dry, as was the case during the fall of 1894. On August 14, 1894, the discharge of the river at Fremont was 1,420 second-feet; on September 17 there was no water passing Columbus, Nebr., nor on October 6. On that date water was found at a depth of 3 feet 8 inches below the surface of the sand in the bed of the river.[1] No systematic measurements of this river have been made on account of the difficulty of ascertaining the amount of water in its broad, shallow channel, and the expense of maintaining observations.

COLUMBUS STATION, ON LOUP RIVER.

This station is located just above the iron bridge of the Union Pacific Railway. The observer is M. Savage, bridge watchman. The distance of the observer's house from the gaging station is about a half mile; from the bridge, 50 yards. The gage is of oak, 3 inches by 6 inches, 12 feet long, fastened by lag screws to a pile which forms part of the training works above the bridge. The rod is vertical.

There is an island at the bend, about 1,000 feet above the bridge. The training works cause the current to set from the shore. In high water the flood passes through willows and underbrush on the opposite side. The 12-foot mark on the rod is 7 feet below a point 2 feet east of the third panel point of the north truss of the east span, counting the end of the span as the first panel point. All levels are taken from the top of the bottom chord. This is not a good location, but after considerable search it seemed to be the best available. Observations were begun October 13, 1894, the water standing then at 4.70 feet on gage, not varying greatly from this during the remainder of the year.

KANSAS BASIN, IN NEBRASKA.

The Kansas River is formed by the union of a number of streams rising in the plains region not far from the boundary between Colorado, Nebraska, and Kansas. The most northerly of its branches is the Republican River, which, rising in Colorado, flows as a small stream through the southwestern portion of Nebraska, and continues easterly north of the State line for over half the distance of this boundary.

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[1] O. V. P. Stout, Bulletin of the Agricultural Experiment Station of Nebraska, vol. 7, p. 156.

Measurements of some of the more important of the headwaters of Republican River have been made, the principal of these being the North and South Forks, near Benkelman, and of the Frenchman River at Palisade. Other stations on the tributaries of Kansas River will be established in Kansas, in order to obtain the discharge from the Solomon, Saline, Smoky Hill, as well as of the Republican near its mouth.

BENKELMAN STATION, ON NORTH FORK OF REPUBLICAN RIVER.

This station is on the left bank of the stream, about one-third of a mile southeast of the house of Mr. L. Morse, a farmer, who serves as observer, and about 2 miles west of Benkelman. The gage consists of an oak stick 2 inches wide by 6 inches deep and 10 feet long. It is inclined 30° to the horizontal, footmarks being 2 feet apart along the rod. It rests directly on beveled blocks, which in turn are supported by 6 by 8 inch cross-ties, well bedded, tamped, and covered. Lag screws are put through the rod, block, and into the ties. The channel at this point consists of loose sand and is nearly straight. The 5-foot mark on the rod is 1.62 feet above the top of the oak stake, about 5 feet southeast of the corner post of the fence around Morse's Grove.

Observations at this point were begun on November 4, 1894, and continued throughout the year. A measurement made by Prof. O. V. P. Stout, December 9, 1894, when the water stood at a height of 1.74 feet, showed a discharge of about 75 second-feet. The height of water was fairly constant.

BENKELMAN STATION, ON SOUTH FORK OF REPUBLICAN RIVER.

This station is located about one-fifth of a mile west of the road running south from Benkelman and close beside the road which runs west from the south bound road just after crossing North Fork, on the left bank of the river. The observer is Mr. Joseph L. Wright, jr. The distance of the observer's house from the gaging station is about 1 mile. The gage is of the same character as that on the North Fork of Republican River, except that the rod is 12 feet long. The channel is sandy and straight, but only about 150 yards below a bend. The 6-foot mark on the rod is 0.11 foot higher than the top of the oak stake by the fence post north and east of the road.

PALISADE STATION, ON FRENCHMAN RIVER.

Observations of river height are taken immediately above the bridge of the Burlington and Missouri River Railroad, about three-fourths of a mile above the railroad station at Palisade, Nebr. The observer is Mr. J. M. Reed, a farmer living at a distance of about 75 yards from the gage. This consists of an oak stick, 2 by 4 inches and about 14 feet long. One end is buried in the sand, and the other is fastened by lag screws to two 6 by 8 inch cross-ties about 5 feet long, each bedded

and covered. This rod is in a small recess of the bank, and is inclined at an angle of about 30° to the horizontal, the footmarks being 2 feet apart along the rod. The 7-foot mark on the rod is 0.89 foot below the top of the screw thread on the bottom of the east side of the north pile of the second bent from Palisade. The channel is of loose sand, nearly straight at this locality. Measurements of discharge are made about 25 feet above the gage. One of these on December 28, 1894, gave for a height of 1.87 feet a discharge of 116 second-feet. Observations were begun on October 14, 1894, and were continued throughout the year.

ARKANSAS BASIN, IN COLORADO.

A large number of discharge measurements have been made at various points upon this stream and its tributaries, and a few of the stations established in 1889 have been maintained with a fair degree of continuity. It has been the intention to make a thorough study of this river, since it involves many problems of great importance, some of them interstate in character, and affords unusual facilities in the way of storage for the conservation of the waters of floods which will result in increased development of irrigation below. The highest station—that at Hayden—is primarily for the purpose of obtaining the quantity of water which might be held by storage in Twin Lakes or other reservoir sites, while measurements at Canyon City give the total flow of the stream at the point where the river is most regular in its behavior and least likely to be affected by cloud-bursts. Measurements at Pueblo, La Junta, and at Holly, near the State line, give, of course, results as affected by diversions at points above.

HAYDEN STATION, ON ARKANSAS RIVER.

This station is located at bridge 203A, on the Denver and Rio Grande Railway, 1¼ miles from Hayden section house. The observer is Mr. J. Burns, section foreman at Hayden. The distance of the observer's house from the gaging station is 1¼ miles. The gage is of pine or spruce bridge timber, 16 feet long. One end rests on the bottom. It is inclined 2.5 to 1, making the distance between the footmarks 2.5 feet. The gage is fastened to the wooden revetment at the north end of the bridge with a seven-eighths-inch bolt and five 10-inch bridge spikes. It will stay as long as the revetment stands. The character of the channel is coarse gravel. The top of the revetment timber at the south end of the revetment is on a level with the point 6.04 feet of the gauge. The measurements of discharge were made 14 feet south of the north end of bridge 203A. This is a reasonably good location.

A measurement made September 24, 1894, by Mr. Arthur P. Davis, showed a mean velocity of 1.93 feet and discharge of 114 second-feet; a second measurement October 16 gave 91 second-feet.

CANYON STATION, ON ARKANSAS RIVER.

Observations at this point were begun on April 17, 1889, the station being established here by Mr. Robert Robertson. The record has been maintained since that time, with occasional breaks due to absence or change of observer. This locality is at the Hot Springs Hotel, 1½ miles west of Canyon, Colo., and at the mouth of the Grand Canyon of the Colorado. Two ditches are taken out, one on each side, about this point, but these are easily accessible, and their average discharge is relatively small, except in times of low water. This site was used in 1888 for the same purpose by the State engineer of Colorado, and is highly favorable for obtaining accurate measurement. The channel of the river is straight for several hundred yards, both above and below, and the current, though swift, is not too great at high water nor too sluggish at low stages for satisfactory results. The banks on both sides are high and are not overflowed. The cross section is regular and has not been subject to notable changes, except on the right bank, near the gage, where a sand bar has formed at times of low water.

The gage rod established by Mr. Robertson was of 2 by 6 inch timber, inclined, and attached to the crib of an old bridge on the south or right-hand side of the river, almost directly in front of the hotel. There were two bench marks: No. 1, on the top of a log of the crib; elevation, 10.01 feet above the datum. No. 2, in the cleft of a red bowlder at the foot of a charred stump 50 feet down stream and on the same side of the river; elevation, 9.60 feet. On April 13, 1891, the station was inspected by Mr. Frank Tweedy, and a third bench mark was established, this being a bedded rock 40 feet from the north end of the cable, toward Hot Springs Hotel and 10 feet from the river bank. It is marked "B. M. No. 3, U. S. G. S.," and is 15.98 feet above the zero of the gage. The present observer is Dr. J. L. Prentiss.

The measurements were at first made from a car suspended from a cable stretched across the river, the bridge from which measurements were originally made by the State engineer having been destroyed. Later a new suspension bridge was constructed in front of the hotel, necessitating the removal and replacement of the gage, and subsequent measurements were made from this bridge, which, having a clear span, offers no obstruction to the current. Discharge measurements were made by Mr. F. H. Newell in 1893 and 1894, and by Mr. Arthur P. Davis in the fall of 1894. From these the following provisional rating table was constructed as being applicable to the river heights obtained after the spring flood of 1893.

On May 1, 1889, a station 35 miles below Canyon was established at a point where the river flows through a small box canyon about one-half mile long, with almost vertical walls from 20 to 30 feet high. The channel is straight and the river can not overflow. In low stages, however, the bottom silts, forming sand bars, and in high stages the

volume, being confined, acquires a velocity so great that measurements are made with difficulty. A number of small streams flow in between this station and that at Canyon. These are too small to be measured individually, and it was to determine their aggregate value that this station was established. Observations were continued during the summer of 1889, but the locality was abandoned at the end of August.

Rating table for Arkansas River at Canyon, Colorado, based on gagings No. 23 to 28, used after July 1, 1893.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
	Sec. feet.		*Sec. feet.*		*Sec. feet.*		*Sec. feet.*
2.00	130	2.80	510	3.60	1,180	4.30	2,050
2.10	160	2.90	580	3.70	1,290	4.40	2,190
2.20	200	3.00	650	3.80	1,410	4.50	2,315
2.30	245	3.10	730	3.90	1,530	4.60	2,445
2.40	290	3.20	810	4.00	1,650	4.70	2,585
2.50	340	3.30	900	4.10	1,780	4.80	2,735
2.60	390	3.40	990	4.20	1,910	4.90	2,990
2.70	450	3.50	1,080				

Daily gage height of Arkansas River at Canyon, Colorado, for 1893.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Dec.
1	2.15	2.20	2.20	2.75	2.40	4.10	4.65	3.10	3.05	.....
2	2.35	2.35	2.30	2.40	2.20	4.20	4.85	4.05	3.10	.....
3	2.35	2.10	2.50	2.30	2.30	4.30	4.50	2.85	3.10	2.90
4	2.30	2.10	2.20	2.50	2.25	4.20	4.40	2.25	3.20	2.90
5	2.25	2.20	2.20	2.40	2.25	4.25	4.20	2.20	3.20	2.86
6	2.20	2.20	2.30	2.35	2.15	4.20	4.05	2.90	3.10	2.90
7	2.25	2.20	2.35	2.40	2.40	4.45	3.90	3.00	3.00	2.70
8	2.20	2.20	2.40	2.25	2.40	4.55	3.70	3.30	2.95	2.60
9	2.15	2.20	2.40	2.20	2.65	4.90	3.65	3.15	2.90	2.60
10	2.20	2.40	2.35	2.30	2.25	4.65	3.60	3.00	2.90	2.60
11	2.25	2.25	2.25	2.20	2.65	4.90	3.60	2.90	2.75	2.60
12	2.15	2.20	2.40	2.30	2.25	5.10	3.30	2.85	2.75	2.60
13	2.15	2.30	2.25	2.35	2.40	4.90	3.35	2.75	2.75	2.60
14	2.25	2.45	2.15	2.20	3.20	4.95	3.25	2.65	2.70	2.60
15	2.25	2.15	2.30	2.20	3.40	5.45	3.25	2.60	2.70	2.60
16	2.25	2.25	2.20	2.25	3.20	5.60	3.65	2.70	2.65	2.60
17	2.20	2.30	2.20	2.25	3.30	5.95	3.25	2.75	2.65	2.60
18	2.20	2.30	2.25	2.30	4.20	6.00	3.20	2.90	2.65	2.60
19	2.15	2.30	2.20	2.25	4.90	5.90	3.25	3.00	2.55	2.60
20	2.05	2.25	2.35	2.30	5.10	5.80	3.20	2.90	2.50	2.70
21	2.15	2.25	2.30	2.25	5.00	5.80	3.10	2.90	2.50	2.70
22	2.10	2.30	2.30	2.20	4.85	5.30	3.00	2.90	2.45	2.60
23	2.05	2.30	2.20	2.15	4.50	5.40	2.80	2.85	2.45	2.60
24	2.20	2.25	2.30	2.20	4.30	5.00	2.75	2.85	2.45	2.70
25	2.20	2.15	2.25	2.50	4.10	5.35	2.65	2.80	2.40	2.80
26	2.10	2.35	2.25	2.30	4.20	5.15	2.70	2.75	2.40	2.70
27	2.15	2.35	2.25	2.45	4.30	5.10	2.45	2.75	2.40	2.60
28	2.35	2.30	2.20	2.35	4.20	4.90	2.40	2.75	2.45	2.60
29	2.20	.....	2.25	2.20	4.90	4.85	2.70	2.75	2.45	2.60
30	2.20	.....	2.30	2.65	4.50	4.60	2.60	2.80	2.40	2.60
31	2.30	.....	2.90	.....	4.30	.....	2.70	2.80	.....	2.60

Daily gage height of Arkansas River at Canyon, Colorado, for 1894.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.70	2.80	2.80	2.60	3.50	5.20	3.70	3.10	3	2.60	2.30	2.30
2	2.80	2.70	2.90	2.60	3.60	4.80	3.70	3.20	2.90	2.60	2.30	2.30
3	2.70	2.60	2.80	2.60	3.50	4.90	3.70	3.10	2.90	2.50	2.30	2.40
4	2.90	2.60	2.80	2.70	3.50	5.10	3.90	3.00	2.80	2.50	2.30	2.40
5	2.60	2.60	2.70	2.80	3.40	5.30	4.40	3.20	2.90	2.50	2.40	2.40
6	2.70	2.60	2.70	2.80	3.50	5.80	4.40	3.10	2.90	2.50	2.30	2.30
7	2.60	2.70	2.80	2.90	3.60	5.70	4.50	3.00	2.90	2.70	2.40	2.30
8	2.60	2.70	2.80	2.80	3.70	5.80	4.00	2.90	3.00	2.50	2.30	2.40
9	2.60	2.70	2.90	2.80	3.80	5.30	3.90	3.20	3.00	2.50	2.30	2.50
10	2.60	2.60	3.00	2.80	3.90	4.90	3.80	3.10	3.10	2.40	2.30	2.50
11	2.60	2.60	2.90	2.70	4.00	4.70	3.70	3.00	3.10	2.40	2.30	2.40
12	2.60	2.60	3.00	2.70	4.10	4.60	3.60	3.00	3.20	2.40	2.40	2.40
13	2.60	2.60	3.00	2.70	4.20	4.70	3.60	3.10	3.10	2.40	2.30	2.40
14	2.80	2.70	3.10	2.80	4.30	4.80	3.90	3.10	3.10	2.40	2.30	2.40
15	2.70	2.60	3.20	2.90	4.30	4.90	4.00	3.00	3.00	2.40	2.30	2.40
16	2.60	2.60	3.00	3.00	4.20	4.90	4.00	3.00	3.00	2.40	2.30	2.40
17	2.60	2.60	2.90	3.10	4.10	4.80	4.00	3.00	2.90	2.40	2.40	2.30
18	2.60	2.60	2.80	2.90	4.00	4.80	3.90	3.10	2.80	2.30	2.40	2.30
19	2.70	2.60	2.90	2.70	3.90	4.80	4.00	3.10	2.70	2.40	2.30	2.30
20	2.80	2.60	2.80	2.80	4.50	4.70	4.00	3.00	2.70	2.30	2.30	2.30
21	2.80	2.60	2.70	2.90	4.70	4.60	4.00	3.20	2.70	2.30	2.30	2.30
22	2.80	2.70	2.60	3.00	4.90	4.40	4.00	3.10	2.60	2.30	2.40	2.30
23	2.90	2.80	2.60	3.10	4.70	4.40	3.70	3.10	2.60	2.30	2.30	2.30
24	2.90	2.60	2.60	3.20	4.60	4.30	3.50	3.10	2.60	2.30	2.30	2.30
25	2.80	2.60	2.50	3.30	4.40	4.20	3.40	3.20	2.60	2.30	2.40	2.30
26	2.70	2.70	2.60	3.40	4.50	4.10	3.30	3.10	2.60	2.30	2.40	2.40
27	2.60	2.70	2.60	3.40	4.50	4.00	3.30	3.00	2.60	2.30	2.40	2.40
28	2.60	2.80	2.60	3.40	4.60	4.00	3.30	3.00	2.70	2.40	2.40	2.30
29	2.60	.....	2.50	3.40	4.80	3.80	3.20	3.10	2.70	2.30	2.30	2.30
30	2.60	.....	2.50	3.50	5.10	3.70	3.10	3.10	2.70	2.30	2.30	2.30
31	2.70	.....	2.50	.....	5.80	.....	3.10	3.00	.....	2.30	.....	2.30

LA JUNTA STATION, ON ARKANSAS RIVER.

The gage at this station was established by Mr. F. H. Newell on September 27, 1893, on the left or south bank of the river, near the city pumping station. At this point the banks are steep, being at the outside of one of the curves of the river, while on the other they are somewhat low and shelving. The gage is of oak, 10 feet long, 6 inches wide, 3 inches thick, inclined, 1 foot vertical equaling 1.38 feet on the gage. The upper end is bolted to a cottonwood tree, and the lower end to an oak cross-tie loaded with rock. The gage reads to 6.60 feet, and is notched for each tenth of a foot on the edge, and besides the painted figures is further marked by tacks driven into the oak, the number of tacks indicating the number of feet. A bench mark is painted on the northwest corner of the pump house, about 0.3 foot above the ground, the horizontal line being 11 feet above the datum of the gage. The water at that time stood at 0.45 foot, and the discharge as measured at the wagon bridge below town was 24 second-feet.

Records of height of water were maintained from December 5, 1893, through that and the succeeding year. On May 21, 1894, a measurement was made at the wagon bridge, showing a discharge of 157 second-feet. A few days later occurred one of the heaviest floods of the year, followed by a second flood a week later. At the time of the first flood a number of measurements were made at La Junta and at the railroad crossing at Nepesta, 36 miles above. The storm began on Wednesday evening, May 30, 1894, causing the river to rise rapidly that night, and on May

31 it had flooded the bottoms and washed out the approaches to nearly all of the bridges below Canyon. On June 1, at 4 p. m., a measurement by Mr. F. H. Newell at the wagon bridge at Nepesta showed a discharge of 12,000 second-feet. At that time the water had receded 4 feet below the highest flood mark on the bridge. The maximum surface velocity was 6.7 feet per second, and the mean velocity 4 feet per second. On June 2 the water had fallen 5.3 feet below high-water mark, and had a maximum surface velocity of 5.6 feet per second. The measurement was made while the water was falling rapidly, and the discharge is placed in round numbers at 8,000 second-feet. From a comparison of these measurements with such facts as could be obtained on the ground, an inspection of the flooded area, and the statements of men who were watching the river, the conclusion was reached that about 30,000 second-feet passed the Atchison, Topeka and Santa Fe Railroad bridge at the top of the flood of May 31. This quantity would probably have been larger if the pile bridge with the driftwood against it had not prevented the free flowing of the stream.

The first flood was followed by one a week later of about the same violence. On June 7, 1894, at 9 a. m., the measured discharge at the wagon bridge at La Junta at the time the water was falling from this second flood was 15,000 second-feet. The maximum surface velocity was 6 feet per second, and the height of water on the gage was 7.8 feet. The next day, June 8, the water stood at 6.4 feet on the gage, and the measured discharge was 9,500 second-feet. From these measurements and an examination of flood marks the conclusion was reached that the maximum amount passing the bridge at the time of this flood was 20,000 second-feet, the bridges and approaches holding back the water.

The La Junta station was inspected on October 5, 1894, by Mr. Arthur P. Davis, and a measurement was made, showing that the river was discharging 55 second-feet for a gage height of 0.4. At this part of its course the relation of gage height to discharge, especially during the low stages of the river, is constantly varying, owing to silting and scouring of the muddy channel. It is possible, however, that estimates of a fair degree of reliability can be made by making frequent measurements of discharge.

Daily gage height of Arkansas River at La Junta, Colorado, for 1894.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1.....	1.70	1.00	0.45	0.50	0.30	0.40	17.....	2.25	0.80	1.55	0.30	1.30	0.30
2.....	1.60	.90	.50	.50	.30	.....	18.....	2.00	.60	1.50	.30	1.30	.30
3.....	1.60	3.20	.50	.50	.30	.....	19.....	2.05	.60	1.50	.30	1.40	.30
4.....	1.55	5.00	.40	.35	.30	.....	20.....	2.50	.60	1.40	.30	1.30	.30
5.....	2.55	2.90	.40	.30	.30	.....	21.....	2.70	.60	1.40	.30	1.30	.30
6.....	.....	1.90	.40	.30	.30	.....	22.....	2.50	.50	1.30	.25	1.20	.30
7.....	4.50	1.60	.40	.30	.30	.....	23.....	2.25	.50	1.20	.20	1.25	.30
8.....	3.90	.....	.40	.40	.30	.....	24.....	1.90	1.60	1.00	.20	1.10	.30
9.....	2.90	.....	.35	.35	.30	.30	25.....	1.70	1.30	.90	.20	1.00	1.00
10.....	2.60	1.70	.40	.35	.30	.30	26.....	1.50	1.00	.75	.25	1.00	1.70
11.....	2.30	1.50	(*a*)	.30	.30	.30	27.....	1.50	.60	.65	.20	.90	1.50
12.....	2.10	1.20	3.00	.30	.30	.30	28.....	1.50	.50	.55	.30	.90	1.50
13.....	1.90	.95	2.00	.30	.30	.30	29.....	1.30	.50	.50	.30	.90	1.30
14.....	1.70	.90	1.60	.30	.30	.30	30.....	1.10	.50	.50	.30	.90	1.20
15.....	1.90	.70	1.60	.30	1.30	.30	31.....	1.10	.50	.....	.30	.....	1.20
16.....	2.10	.60	1.60	.30	1.20	.30							

a Washout.

HOLLY STATION, ON ARKANSAS RIVER.

A gage was established at this point by Mr. F. H. Newell on September 26, 1893, on the north side of the west end of bridge No. 362 of the Atchison, Topeka and Santa Fe Railroad Company, 0.9 mile east of the railroad station of Byron. At that time there was no water in the river. The gage consists of an oak plank 16 feet long, 6 inches wide, and 2 inches thick, placed edgewise and inclined at a low angle. The upper end was fastened to an old pile, and the lower end to one of the new supports of the bridge. The edge of the plank is marked to vertical feet and tenths, the inclination being such that 1 foot vertical equals 4.87 feet along the gage rod. Each tenth of a foot vertical is marked by a notch and figures from 0.2 foot up to 3.2 feet, the marking being continued on the vertical pile up to 5.5 feet. The top of the rail is 8.89 feet above the datum of this gage. Besides having painted figures, the height is indicated by tacks driven into the wood. During repairs upon this bridge this gage was transferred and replaced, its position not being verified.

Observations were begun on December 4, 1893, and continued through 1894. On April 15 the observer reported that the river was dry, all of the water being used at points above for irrigation purposes. The river remained dry until the latter part of May, and on June 1 rose 3.5 feet, reaching a height of 4.6 feet on June 3. From this time the water gradually fell off to the first week in July, rising on July 7 to 2.6 feet. On August 25 the channel was again dry, a small amount of water coming down during the next week, following a heavy rain. It was practically dry until September 11, the water rising to a height of 4 feet on September 12, and falling again rapidly, being reported dry on September 23. On October 19 the gage was moved into the main channel; it was again moved on November 26. The following table gives the readings at this point as reported, but from them it is not possible to distinguish the times when the water was actually flowing

in the stream, as the observer did not record the fact as to whether the water around the gage was in motion or was merely standing in large pools in the river channel:

Daily gage height of Arkansas River at Byron, Colorado, for 1894.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.90	1.30	1.40	0.30	.....	3.50	1.10	0.50	0.00	0.00	0.90	0.20
2	.95	1.30	1.60	.30	.....	4.50	1.00	.40	0.00	0.00	.90	.20
3	.95	1.30	1.40	.30	.....	4.60	.90	.40	0.00	0.00	.90	.20
4	1.00	1.30	1.00	.30	.....	3.50	.80	.30	0.00	0.00	.90	.20
5	1.00	1.30	.90	.30	.....	2.80	1.30	2.00	0.00	0.00	.90	.20
6	1.05	1.30	.90	.20	.....	2.70	1.50	1.60	0.00	0.00	.90	.20
7	1.20	1.30	.90	.20	.....	2.50	2.60	.60	0.00	0.00	.80	.20
8	1.20	1.40	.60	.20	.....	4.20	2.60	.50	0.00	0.00	.80	.20
9	1.20	1.40	.40	.20	.....	3.00	2.60	.40	0.00	0.00	.80	.20
10	1.20	1.40	.40	.20	.....	2.80	2.40	.20	0.60	0.00	.80	.20
11	1.20	1.40	.60	.20	.....	2.50	2.30	.20	3.80	0.00	.80	.20
12	1.20	1.40	.60	.20	.....	2.40	2.20	.50	4.00	0.00	.80	.20
13	1.20	1.40	.60	.20	.....	2.10	2.10	.50	1.80	0.00	.80	.20
14	1.20	1.40	.60	.30	.....	2.00	2.00	.40	1.00	0.00	.80	.20
15	1.20	1.50	.50	.30	.....	2.00	1.70	.40	.80	0.00	.80	.20
16	1.20	1.60	.50	.30	.....	2.00	1.40	.40	.60	0.00	.80	.20
17	1.20	1.60	.40	.30	.....	2.00	1.10	.30	.50	0.00	.90	.20
18	1.30	1.60	.30	.20	.....	1.90	.80	.30	.30	0.00	1.00	.20
19	1.30	1.60	.30	.20	.....	1.90	.80	.20	.30	1.00	1.10	.20
20	1.30	1.60	.30	.20	.....	1.80	.80	.20	.30	1.00	1.20	.20
21	1.30	1.60	.20	(*a*)	.....	1.80	.70	.10	.30	1.00	1.20	.20
22	1.20	1.60	.20	.....	.....	1.70	.70	0.00	.20	1.00	1.20	.20
23	1.20	1.60	.60	.....	.....	1.60	.60	0.00	0.00	1.00	1.20	.20
24	1.20	1.60	.40	.....	.....	1.60	.50	0.00	0 00	1.00	1.20	.20
25	1.20	1.40	.60	.....	.....	1.40	.50	0.00	0.00	.90	1.20	.20
26	1.00	1.40	.50	.....	.....	1.30	.50	.50	0.00	.90	.20	.20
27	1.00	1.40	.40	.....	80	1.20	.50	.40	0.00	.90	.20	.20
28	1.00	1.50	.40	.....	40	1.20	.40	.30	0.00	.90	.20	.20
29	1.30	.....	.40	.....	30	1.20	.40	.10	0.00	.90	.20	.20
30	1.30	.....	.30	.....	30	1.20	.30	0.00	0.00	.90	.20	.30
31	1.30	.....	.30	.....	60	.....	.30	0.00	.....	.90	.....	.30

a River dry from April 21 to May 27 because of water being used for irrigation.

CANADIAN BASIN, IN NEW MEXICO.

Few if any measurements have been made in this important basin, which drains the northeastern corner of New Mexico. There is, however, a demand for information pertaining to the headwaters of this stream and applicable to the tributaries at points where their waters may be utilized. A station has therefore been established on Mora River, at Watrous, a point where measurements can be conducted with the least expense.

WATROUS STATION, ON MORA RIVER.

This station is located at the Atchison, Topeka and Santa Fe Railroad bridge, 1½ miles east of Watrous, N. Mex. The observer is Mr. Frank Flaiz, section foreman at Watrous. The station was established by Mr. Arthur P. Davis on October 4, 1894. The gage is fastened to the oak timber of a retaining wall, just north of the east end of the bridge. The observer's house is distant from the gaging station about 1½ miles. The gage, of pine timber, is vertical, spiked and bolted to the oak retaining wall, painted white, and graduated black. The character of the channel is shifting. The point 12.62 of the gage is level with the top of the east abutment of the bridge.

RIO GRANDE BASIN, IN COLORADO, NEW MEXICO, AND TEXAS.

This drainage basin has been described in some detail in the Twelfth Annual Report, Part II, Irrigation, pages 240–290. A number of the river stations located in 1889 have been maintained, while others have been established during 1894. The problems along this river are largely interstate or international in character, the development of agriculture by irrigation in Colorado tending to reduce the amount of water available in New Mexico, and the increased use in New Mexico and Colorado apparently resulting in a diminished flow at points where irrigating canals in Texas and in the Republic of Mexico have been accustomed to take their supply. Records of river flow have been maintained under difficulties, the principal of which was the lack of funds sufficient to induce observers to continue unbroken series of readings, and because of the impossibility of inspecting the gages and making check measurements at necessary times.

DEL NORTE STATION, ON THE RIO GRANDE.

Measurements and observations were first begun in the vicinity of Del Norte in 1889, by Mr. George T. Quinby. The object of the measurements was to obtain the flow of the river before water was diverted for the agricultural region of the San Luis Valley, and, by a comparison of this with the figures obtained at Embudo, to acquire data as to the effect of the numerous ditches taking out water between the two points. The river 25 miles above Del Norte flows out of the canyon at Wagon Wheel Gap. Little water, however, is diverted until the edge of the San Luis Valley is reached, the largest canal heading near the town of Del Norte. During freshets the river divides into a number of channels, making it difficult to obtain measurements near town. In order to avoid the expense of establishing a station during time of high water, the first measurements—those about June 1—were made from several bridges crossing the numerous branches. The results were not wholly satisfactory, and on June 25 a station was established above the branches. Later a locality about 2 miles farther up was chosen. Observations at this point were kept continuously from September, 1889.

The station is above all the irrigating ditches of importance. The river flows in one channel, about 175 feet wide and of very regular section. The banks on each side are steep, and the water is reported never to overflow. The course of the stream is straight for several hundred yards both above and below the section. An inclined gage is set, at an angle of about 30° to the horizontal, on the left bank, and is referred to bench marks. As noted on October 10, 1891, No. 1 is a large nail in the root of a tree 15 feet northwest of the end of the cable on left bank of river. Bench mark No. 2 is a large nail in the

root of a tree 25 feet southwest of the end of the inclined gage. Both bench marks are 7.54 feet above the datum of the gage.

The station is equipped with a flatboat, 4 feet wide and 14 feet long, attached by rope and tackle to a five-eighths-inch wire cable fastened to a large cottonwood tree on the left bank, and to a sand anchor on the right bank. The inclined gage is 2 inches by 6 inches. On March 9, 1890, the gage was carried away by the ice, and was replaced on March 22. A self-recording nilometer was erected at this station, but after trial it was found that better results could be obtained by daily readings.

Daily gage height of Rio Grande at Del Norte, Colorado, for 1893.

Day	Jan.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.15	1.80	2.80	4.40	2.45	2.00	1.80	1.75	1.55	1.85
2	3.10	1.85	2.75	4.50	2.30	2.10	1.85	1.70	.....	.....
3	3.10	1.90	2.70	4.50	2.25	2.10	1.85	1.70	1.55	1.50
4	3.10	2.05	2.65	4.60	2.15	2.00	1.80	1.70	.....	.....
5	3.10	2.20	2.60	4.40	2.10	1.80	1.70	.....	1.50	2.00
6	3.10	2.15	2.60	4.20	2.10	1.80	1.70	1.65	.....	.....
7	3.05	2.10	2.70	4.20	2.05	1.75	1.70	.....	1.45	2.20
8	3.05	2.05	2.70	4.50	2.00	1.80	1.65	1.60	.....	.....
9	3.00	2.05	2.80	4.50	2.00	1.80	1.60	.....	1.45	2.55
10	3.00	2.05	2.85	4.50	1.90	1.75	1.60	1.60	.....	.....
11	2.95	2.10	3.00	4.40	1.95	1.70	1.60	.....	1.50	2.60
12	2.90	2.05	3.35	4.30	2.05	1.70	1.55	1.55	.....	.....
13	2.90	2.00	3.80	4.20	2.20	1.65	1.55	.....	1.55	2.50
14	2.90	1.95	3.90	3.90	2.10	1.65	1.50	1.60	.....	.....
15	2.90	1.90	3.95	3.80	2.00	1.70	1.50	.....	1.60	2.50
16	2.95	1.95	4.20	3.70	1.90	1.75	1.50	1.55	.....	.....
17	2.95	2.00	4.40	3.60	1.85	1.75	1.60	.....	1.60	2.50
18	2.90	2.10	4.90	3.50	1.80	1.75	1.70	1.60	.....	.....
19	2.90	2.15	4.90	3.40	1.90	1.80	1.65	.....	1.55	2.55
20	2.85	2.10	4.85	3.30	1.75	1.80	1.65	1.55	.....	.....
21	2.85	2.10	4.85	3.15	1.75	1.85	1.60	.....	1.60	2.50
22	2.80	2.20	4.75	3.00	1.70	1.85	1.60	1.55	.....	.....
23	2.80	2.25	4.85	3.00	1.70	1.80	1.60	.....	1.65	2.55
24	2.80	2.40	4.80	2.90	1.80	1.75	1.55	1.60	.....	.....
25	2.80	2.65	4.65	2.80	1.85	1.70	1.60	.....	2.00	2.70
26	2.85	2.80	4.40	2.75	1.90	1.65	1.60	1.60	.....	.....
27	2.90	2.90	4.25	2.70	1.90	1.60	1.65	.....	2.10	2.80
28	2.95	2.95	4.20	2.60	1.90	1.80	1.70	1.55	.....	.....
29	3.00	3.05	4.10	2.50	1.80	1.80	1.75	.....	2.05	2.75
30	2.95	3.00	4.25	2.50	1.80	1.75	1.70	1.60	.....	.....
31	2.90	.....	4.35	.....	1.95	1.80	.....	.....	.....	2.70

Daily gage height of Rio Grande at Del Norte, Colorado, for 1894.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	3.05	3.05	.....	.....	3.50	1.70	.....	1.70	1.75	.....	.....
2	2.85	.....	.....	2.05	3.10	.....	.....	1.65	.....	.....	1.60	1.44
3	.....	3.05	3.10	.....	.....	3.40	1.70	.....	1.75	1.85	.....	.....
4	2.90	.....	.....	2.00	3.30	.....	.....	1.60	.....	.....	1.60	1.46
5	.....	3.00	3.10	.....	.....	3.30	1.70	.....	1.70	1.80	.....	.....
6	2.95	.....	.....	2.10	3.85	.....	.....	1.60	.....	.....	1.60	1.52
7	.....	3.00	3.00	.....	.....	3.30	1.70	.....	1.70	1.80	.....	.....
8	3.05	.....	.....	2.20	3.85	.....	.....	1.55	.....	.....	1.60	1.58
9	.....	2.95	3.00	.....	.....	3.10	1.70	.....	1.80	1.75	.....	.....
10	3.10	.....	.....	2.10	3.95	.....	.....	1.60	.....	.....	1.60	1.60
11	.....	3.00	2.95	.....	.....	2.90	1.70	.....	1.90	1.70	.....	.....
12	3.15	.....	.....	2.15	4.20	.....	.....	1.60	.....	.....	1.60	1.58
13	.....	3.00	2.90	.....	.....	2.78	1.60	.....	1.75	1.65	.....	.....
14	3.00	.....	.....	2.25	4.40	.....	.....	1.65	.....	.....	1.55	1.54
15	.....	3.00	3.05	.....	.....	2.60	1.55	.....	1.70	1.60	.....	.....
16	3.05	.....	.....	2.30	3.90	.....	.....	1.70	.....	.....	1.50	1.58
17	.....	2.95	3.15	.....	.....	2.40	1.65	.....	1.65	1.60	.....	.....
18	3.00	.....	.....	2.25	4.10	.....	.....	1.75	.....	.....	1.50	1.62
19	.....	2.90	2.95	.....	.....	2.30	1.90	.....	1.60	1.65	.....	.....
20	3.05	.....	.....	2.50	4.60	.....	.....	1.80	.....	.....	1.45	1.68
21	.....	2.95	2.70	.....	.....	2.30	1.85	.....	1.60	1.70	.....	.....
22	3.00	.....	.....	2.70	4.10	.....	.....	1.95	.....	.....	1.45	1.72
23	.....	3.00	2.25	.....	.....	2.10	1.80	.....	1.55	1.65	.....	.....
24	2.95	.....	.....	2.95	3.50	.....	.....	2.00	.....	.....	1.50	1.76
25	.....	3.00	2.15	.....	.....	2.00	1.75	.....	1.55	1.65	.....	.....
26	2.95	.....	.....	3.25	3.30	.....	.....	1.95	.....	.....	1.45	1.80
27	.....	3.00	2.10	.....	.....	1.95	1.65	.....	1.50	1.60	.....	.....
28	3.00	.....	.....	3.60	3.40	.....	.....	1.80	.....	.....	1.40	2.02
29	.....	.....	2.00	.....	.....	1.85	1.60	.....	1.70	1.65	.....	.....
30	3.00	.....	.....	3.05	3.50	.....	.....	1.80	.....	.....	1.40	2.18
31	.....	.....	.....	2.05	.....	.....	1.60	.....	.....	1.60	.....	.....

ALAMOSA STATION, ON THE RIO GRANDE.

This station is located at bridge 249A of the Denver and Rio Grande Railroad, about one-half mile east of Alamosa, Colo. The observer is Mr. E. L. McKinnon, foreman of section 11. The gage is a 2 by 6 inch plank, painted white, and graduated in black to tenths from a foot to 11.3 feet. It is spiked to the west side of the third pier from the east end on the north side of the bridge. The point 11.25 of the scale is level with the top of the pier.

EMBUDO STATION, ON THE RIO GRANDE.

Embudo is a railroad station on the Denver and Rio Grande Railroad, in Rio Arriba County. The station is in a narrow canyon above the head of the valley in which Espanola and other towns are located, and in which the river Chama joins the Rio Grande. In November, 1888, an examination was made along the main stream for the purpose of selecting a point at which the total discharge of the Rio Grande entering New Mexico could be ascertained. Coming from Colorado southward, this is the first point at which the railroad reaches the river, and for this reason it was finally determined to establish a river station here. Measurements were begun at the rocky narrows, about a mile above the railroad station, but in the spring of 1889 the observations were transferred to a point directly behind the railroad station, for convenience of the observer and consequent reduction of expense.

The inclined gage, constructed at that time, is made of scantling, 4 by 4 inches, spiked to posts set firmly in the ground. It is on the right-hand side of the river, at a place where the slopes are very gentle, and therefore is of considerable length in order to reach out to the low-water channel. It is graduated from about 7.30 feet, the low-water mark, up to 16 feet. The point 3.50 would correspond approximately to the deepest part of the section. The gage is about 75 feet above the cable and is in three parts, with different slopes. The cable is five-eighths-inch wire, with nineteen steel strands. It is fastened to a cedar tree on the left-hand side and to sand anchors on the right. Measurements were originally made from a boat held by traveling pulleys running on the cable. The boat being washed away by flood, later measurements were made from a box suspended from the cable.

Bench mark No. 1 is on a rock near the end of the cable, on the left-hand bank, marked "B. M." with white paint. It is 20.66 feet above zero of the gage. Bench mark No. 2 is on a rock about 100 feet above the cable, on the left bank of the river, and is marked "B. M." with white paint. It is 18.79 feet above datum. Bench mark No. 3 is a notch cut in the southeast corner of the station house, about 2 feet above the level of the platform, and is 30.48 feet above datum.

Observations at this point were maintained for a number of years. In 1893 the record is deficient from November 4 to December 4, and in 1894 no reports were received from March 1 to September 15. The station was inspected September 30, 1894, by Mr. Arthur P. Davis, who at that time made a measurement of discharge, showing that for a height of 7.7 feet the river was carrying 284 second-feet. On the next day a flood occurred, and measurements were attempted, although the height of water was fluctuating considerably. The computed discharge was 1,138 second-feet. The changes in the channel at this point are not great, but are sufficient to vitiate the rating table formerly used, and therefore computations of discharge have not been made pending construction of a better rating table.

Daily gage height of Rio Grande at Embudo, New Mexico, for 1893.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	7.90	8.15	8.05	8.75	10.65	11.50	8.25	7.70	7.90	8.20	8.00	.....
2	7.90	8.15	8.05	8.85	10.55	11.60	8.15	8.50	7.80	8.15	8.00	.....
3	8.00	8.15	8.20	9.10	10.20	11.60	8.00	8.50	7.75	8.20	7.95	.....
4	8.00	8.05	8.30	9.25	10.00	11.60	7.85	7.80	8.00	8.20	7.95	8.02
5	8.00	8.15	8.30	9.35	9.90	11.60	7.75	7.75	7.90	8.20	.....	8.01
6	8.00	8.25	8.25	9.45	10.00	11.60	7.70	7.60	7.80	8.15	.....	7.98
7	8.05	8.20	8.30	9.60	10.15	11.50	7.60	7.55	7.85	8.20	.....	7.98
8	8.05	8.15	8.30	9.70	10.05	11.30	7.60	7.60	7.85	8.10	.....	8.01
9	8.00	8.20	8.35	9.75	9.90	11.30	7.60	7.65	7.80	8.05	.....	8.00
10	8.05	8.25	8.40	9.65	9.75	11.50	7.55	7.55	7.80	8.10	.....	7.98
11	8.00	8.30	8.25	9.60	9.65	11.60	9.30	7.50	7.80	8.05	.....	7.97
12	8.00	8.20	8.15	9.50	9.70	11.60	7.70	7.45	7.75	8.00	.....	7.97
13	7.95	8.30	8.20	9.45	10.25	11.50	7.50	7.40	7.70	8.00	.....	7.95
14	7.90	8.30	8.20	9.30	11.05	11.20	7.45	7.40	7.75	8.05	.....	7.98
15	7.95	8.10	8.40	9.20	11.65	11.10	7.40	7.40	7.70	8.05	.....	8.00
16	8.00	8.05	8.25	9.10	11.70	10.90	7.40	7.40	7.70	8.00	.....	7.96
17	8.00	8.15	8.20	9.05	11.75	10.60	7.35	7.40	7.75	8.00	.....	7.95
18	7.95	8.20	8.25	9.00	11.90	10.40	7.35	7.50	7.95	8.00	.....	7.94
19	7.90	8.25	8.35	9.10	12.40	10.30	7.35	7.45	7.85	8.00	.....	7.92
20	7.85	8.25	8.40	9.20	12.65	10.10	7.30	7.70	7.85	8.00	.....	7.93
21	7.90	8.25	8.55	9.45	12.60	9.90	7.35	7.65	7.85	8.00	.....	7.93
22	8.05	8.25	8.70	9.55	12.45	9.75	7.50	7.70	7.80	8.00	.....	7.95
23	7.95	8.20	8.70	9.60	12.20	9.60	7.40	7.60	7.80	8.05	.....	7.94
24	7.95	8.20	8.70	9.85	11.85	9.40	7.45	7.55	7.80	8.00	.....	7.95
25	7.95	8.10	8.65	10.40	11.55	9.15	7.50	7.60	7.80	8.00	.....	7.95
26	8.00	8.20	8.50	10.55	11.40	8.95	7.55	7.60	7.80	8.00	.....	7.95
27	8.00	8.20	8.40	10.55	11.40	8.80	7.80	7.70	8.15	8.00	.....	7.94
28	8.00	8.00	8.40	10.40	11.50	8.70	7.50	8.20	8.25	8.00	.....	7.95
29	8.00	.....	8.40	10.30	11.35	8.60	7.40	7.80	8.25	8.00	.....	7.94
30	8.00	.....	8.55	10.35	11.30	8.45	7.45	7.85	8.20	8.00	.....	7.95
31	8.05	.....	8.65	.....	11.35	.....	7.60	8.05	.....	8.00	.....	7.92

Daily gage height of Rio Grande at Embudo, N. Mex., for 1894.

Day.	Jan.	Feb.	Sept.	Oct.	Nov.	Dec.	Day.	Jan.	Feb.	Sept.	Oct.	Nov.	Dec.
1	7.95	7.95	.....	9.55	7.08	8.00	17	7.95	8.00	7.10	7.08	8.00	8.00
2	7.95	7.95	.....	8.08	7.08	8.00	18	7.95	8.00	7.10	7.08	8.00	7.09
3	7.95	7.95	.....	8.05	7.08	8.00	19	7.95	8.00	7.10	7.09	8.00	8.02
4	8.00	7.95	.....	8.03	7.08	7.09	20	7.95	8.05	7.10	.....	7.09	8.01
5	7.95	7.95	.....	8.02	7.08	7.09	21	7.95	8.00	7.10	7.08	7.09	8.00
6	7.95	7.95	.....	8.01	7.08	8.00	22	7.95	8.00	7.10	7.08	7.09	8.01
7	7.95	7.95	.....	8.00	7.08	7.09	23	7.95	8.00	.....	7.09	8.00	8.01
8	7.95	7.95	.....	7.09	7.09	7.09	24	7.95	8.00	.....	8.03	8.00	8.03
9	7.95	7.95	.....	7.09	7.08	7.09	25	7.95	8.00	.....	8.04	8.00	8.01
10	7.90	7.95	.....	7.08	7.08	7.09	26	7.95	8.00	.....	8.04	7.09	8.00
11	7.90	7.90	.....	7.08	7.09	7.09	27	8.00	8.00	.....	7.08	7.09	7.09
12	7.90	7.90	.....	7.08	7.09	8.00	28	8.00	8.00	.....	7.08	7.09	7.09
13	7.90	7.95	.....	7.08	7.09	8.00	29	7.95	.....	.....	7.08	8.00	7.09
14	7.90	8.00	.....	7.08	7.09	8.00	30	7.95	.....	7.10	7.08	8.00	7.09
15	7.90	8.00	.....	7.08	7.09	8.01	31	7.95	.....	.....	7.08	.....	7.09
16	7.90	8.00	7.10	7.08	7.09	8.01							

WATER TANK STATION, ON THE RIO GRANDE.

This station is located about one-fourth of a mile above Water Tank, a section on the Santa Fe Southern Railroad, below Espanola. It was established by Messrs. Arthur P. Davis and P. E. Harroun on February 1, 1895. The observer is Mr. Thomas Dupre, section foreman, whose house is distant from the gaging station about one-fourth of a mile. The inclined portion of the gage is marked from 3.5 feet to 10.6 feet; the vertical portion from 10.6 feet to 16 feet. The inclined part of the gage is braced with wood and anchored with stones. The

upper part is set in the ground, leaning against a huge bowlder, and is held in that position by wire, well tightened. The highest point of the bowlder is marked with a black cross, and is 6.815 feet above the 11-foot mark. Measurement was made from gaging box suspended from cable placed across just above the gage. The channel is sandy and shifting.

SAN MARCIAL STATION, ON THE RIO GRANDE.

This station is located about one-half mile south of San Marcial, N. Mex., at the bridge of the Atchison, Topeka and Santa Fe Railroad. It was established by Mr. Arthur P. Davis on January 29, 1895. The observer is Mr. Bert Halseth, San Marcial, N. Mex., whose house is about one-half mile distant. The gage is of hard pine timber, 9 by 5 inches by 25 feet, anchored and bolted to the east end of the second pier from the south. It is inclined and painted white. The distance between the footmarks is 1.6 feet. The 13-foot mark is level with the extension of the pier, to which the gage is anchored. The 15-foot mark is level with the top of the capstone on which the bridge truss rests. The shifting channel is of sand and mud. Measurements were made from the same bridge. On August 8, 1889, a station was established near San Marcial, and a measurement was made which gave a discharge of 19 second-feet. Soon after this date, however, the river gage was destroyed and the locality was abandoned until 1895.

EL PASO STATION, ON THE RIO GRANDE.

This station is located at the pump house of the smelting works near the station "Town," on the Atchison, Topeka and Santa Fe Railroad, 1½ miles above Old Fort Bliss. It was established on January 24, 1895, by Mr. Arthur P. Davis. The observer is Mr. C. T. Pelham, of El Paso, Tex. The distance from the gage to the pump house is about 50 feet. The gage is of 4 by 6 inch timber, inclined, bolted to solid rock; is 24 feet long, and is continued upward on a 2 by 4 inch by 12-foot piece. The distance between the footmarks is 2.9 feet. The bench mark is an iron core in the center of the masonry monument that marks the corner of the smelter company's land, on a rock knoll just above the gage. It is 8.04 feet above the 11-foot mark on the gage. Measurement was made from a cable just below the gage.

The first river station on the Rio Grande near El Paso was at Old Fort Bliss, about 1,500 feet above the Mexican dam. Observations and measurements were made here from May 10, 1889, until the end of June, 1893, except at times when the river was dry. Later, during a sudden flood, the gage was deeply buried in mud, and on the abandonment of Old Fort Bliss the river rods and equipment were stolen, necessitating

the refurnishing of a new station. The following rating table and list of discharges apply to the old station:

Rating table for Rio Grande at El Paso, Texas.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
	Sec. feet.		*Sec. feet.*		*Sec. feet.*		*Sec. feet.*
4.00	25	6.00	770	8.00	6,060	10.00	11,780
4.10	30	6.10	890	8.10	6,345	10.10	12,070
4.20	35	6.20	1,040	8.20	6,630	10.20	12,360
4.30	40	6.30	1,240	8.30	6,915	10.30	12,650
4.40	45	6.40	1,500	8.40	7,200	10.40	12,950
4.50	50	6.50	1,785	8.50	7,485	10.50	13,250
4.60	57	6.60	2,070	8.60	7,770	10.60	13,550
4.70	66	6.70	2,355	8.70	8,055	10.70	13,850
4.80	80	6.80	2,640	8.80	8,340	10.80	14,150
4.90	96	6.90	2,925	8.90	8,625	10.90	14,450
5.00	116	7.00	3,210	9.00	8,910	11.00	14,750
5.10	140	7.10	3,495	9.10	9,195	11.10	15,050
5.20	170	7.20	3,780	9.20	9,480	11.20	15,360
5.30	210	7.30	4,065	9.30	9,765	11.30	15,670
5.40	260	7.40	4,350	9.40	10,050	11.40	15,980
5.50	320	7.50	4,635	9.50	10,335	11.50	16,300
5.60	390	7.60	4,920	9.60	10,620	11.60	16,620
5.70	470	7.70	5,205	9.70	10,910	11.70	.....
5.80	560	7.80	5,490	9.80	11,200	11.80	.....
5.90	660	7.90	5,775	9.90	11,490	11.90	.....

Daily gage height of Rio Grande at El Paso, Texas, for 1893.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	Day.	Jan.	Feb.	Mar.	Apr.	May.	June.
1.....	5.00	4.95	5.05	.....	6.80	5.90	17.....	5.05	5.20	.....	7.05	7.30	5.10
2.....	.....	4.90	5.05	.....	6.60	5.90	18.....	5.05	5.30	.....	7.00	8.15	5.10
3.....	.....	5.10	5.05	.....	6.90	5.80	19.....	5.05	5.55	.....	6.00	8.10	5.00
4.....	5.05	4.90	5.00	.....	7.40	5.80	20.....	5.05	5.50	.....	5.80	8.10	4.75
5.....	5.15	4.80	5.05	.....	8.10	5.65	21.....	5.05	5.40	.....	5.60	8.10	4.70
6.....	5.05	4.80	5.00	.....	7.85	5.60	22.....	5.05	5.20	.....	5.40	7.95	4.65
7.....	5.04	4.70	4.90	.....	7.25	5.55	23.....	5.00	5.15	.....	5.05	7.95	4.50
8.....	5.05	4.65	.....	.....	6.80	5.50	24.....	5.10	5.10	.....	4.85	8.00	4.25
9.....	5.10	4.65	.....	.....	6.75	5.60	25.....	5.10	5.10	.....	6.10	8.20	4.20
10.....	5.05	5.05	.....	.....	6.80	5.55	26.....	5.20	5.05	.....	6.10	7.90	4.20
11.....	5.10	5.10	.....	.....	6.95	5.50	27.....	5.20	5.00	.....	6.00	7.10	4.05
12.....	5.05	5.05	.....	.....	6.95	5.45	28.....	5.25	5.05	.....	6.30	6.90	4.05
13.....	5.10	4.95	.....	5.70	6.40	5.20	29.....	5.20	.....	.....	6.95	6.60	4.00
14.....	5.10	5.00	.....	5.80	6.35	5.20	30.....	5.10	.....	.....	7.00	6.35	3.90
15.....	5.00	5.15	.....	6.10	5.90	5.05	31.....	5.05	.....	.....	.....	6.05	.....
16.....	5.10	5.25	.....	7.10	6.00	5.10							

COLORADO BASIN, IN COLORADO, UTAH, AND ARIZONA.

The system of great rivers which drains the interior of the continent and discharges through the Colorado into the Gulf of California is one of the most interesting and at the same time one of the least apparent value to the needs of mankind. As a whole the basin is characterized by deep gorges and stupendous canyons, in whose narrow bottoms the streams glide swiftly to the sea. The possible water power is very great, but its probable utilization at present is little short of chimerical. Although a considerable amount of water is discharged from the basin and flows near lands possessing great fertility, yet a relatively small amount can be diverted for irrigation of the soil, owing to the depths to which the flowing waters have cut the channel. It is only near the headwaters that the streams can be utilized to water agricultural lands.

Series of measurements have been begun on some of the more important tributaries, viz, at Grand Junction, Colo.; at Blake and Helper, Utah; at Arizona Dam, above Phœnix, Ariz., and on the main Colorado itself at Yuma, these being mainly for the purpose of obtaining data of general value rather than of local application in questions of immediate water supply.

GRAND JUNCTION STATION, ON GUNNISON RIVER.

This station is located at the pump house of the Denver and Rio Grande Railroad, 1 mile from town, beyond the railroad bridge across Grand River. It was established on October 19, 1894, by Mr. Arthur P. Davis. The observer is Mr. Frank Adair, engineer at the pump house. The gage is of pine timber, vertical, 5 by 5 inches, fastened to bolts set in the stone wall of the pump house. It is painted white and black. The discharge on October 18, 1894, for a height of 1.25 feet was 748 second-feet.

GRAND JUNCTION STATION, ON GRAND RIVER.

This station is located at the north end of the wagon bridge across Grand River at Grand Junction, on the west side of the first abutment. It was established by Mr. Arthur P. Davis, on October 18, 1894. The observer is Mr. B. W. Vedder, engineer of the city waterworks. The station is distant from the pump house about 300 feet. The gage is vertical, of 4 by 6 inch pine timber, and is fastened to bolts set in the stone abutment. The timber and gage are painted white and graduated in black. The point 11.95 of the gage is level with the sandstone coping on which the bridge truss rests. Measurements made from the wagon bridge on October 18, 1894, gave for a height of 0.6 feet a discharge of 1,585 second-feet.

BLAKE STATION, ON GREEN RIVER.

This station is located one-half mile east of Blake, Utah, at the bridge of the Rio Grande Western Railroad, northeast corner, middle pier. It was established on October 20, 1894, by Mr. Arthur P. Davis. The observer is Mr. Frank Jacobs, engineer at the pump house. The station is distant from the pump house about 100 feet. The gage is vertical, of pine timber, 8 by 8 inches by 24 feet, fastened to bolts set in the stone pier and bolted to the iron tension piece. The scale is nailed to a timber. The 18-foot mark on gage is 3 feet below the top of the pier. The river was measured October 21, 1894, from the ferry just above the bridge, showing for a height of 1.98 feet a discharge of 3,035 second-feet.

HELPER STATION, ON PRICE RIVER.

This station is located at the wagon bridge, 1 mile west of Helper, Utah, 50 yards south of the railroad track. It was established by Mr. Arthur P. Davis on October 23, 1894. The observer is Mr. Patrick

Liston, section foreman. The distance of the gaging station from the section house is 1 mile. The gage, of oak timber, is vertical, and is spiked to the north abutment on the west side of the bridge. It is painted white and black. The channel is rocky. The point 7.63 of the gage is level with the top timber of the abutment. The current-meter measurements are taken from the same bridge. The discharge on October 22, 1894, was 34 second-feet.

ARIZONA DAM, ON SALT RIVER.

Computations of the discharge of Salt River for a number of years have been made, based upon measurements of water entering the Arizona Canal and flowing over the dam at its head. This dam, about 30 miles east of Phœnix, Ariz., is described and figured in the Thirteenth Annual Report of the Survey, Part III, Irrigation, pages 221–224. The results of the estimates prepared by Mr. Samuel Davidson and his successors have been given in annual reports of the Survey, but those for 1893 and 1894, if prepared, have not been given out by the company.

A number of attempts have been made by this Survey to obtain accurate measurements of the flow of the Gila River and its tributaries, but owing to the unsettled condition of the country and the difficulty and expense of transportation it has been found impracticable to continue the work, since with the amount available far larger results could be obtained elsewhere. On May 11, 1889, Mr. W. A. Farish, assistant hydrographer, was sent to Arizona to establish a gaging station, and he continued in charge of this work until the end of August, 1890. During that time he placed a number of rain gages, which were, on September 24, 1890, transferred to the Signal Service, and later passed into the charge of the Weather Bureau. He also began observations of evaporation at Tempe, Yuma, and other localities. A reconnaissance was made for the purpose of selecting favorable points for measuring the rivers, but no place suitable for continuous measurements was found on Salt River below the junction with the Verde. About one-half mile above the junction of these two streams there were found localities where work might be done, but unfortunately it was almost impossible to secure a person to make observations of river height. In July, 1889, a station was located on the Salt above the mouth of the Verde, about 2 miles from the Arizona Canal.

An examination of Verde River was made in August, up to Fort McDowell, but no suitable cross section was found. At McDowell the river is almost 1,000 feet wide. The bed is sandy, and is divided into a number of channels or sloughs. About 12 miles above the fort the river emerges from a box canyon, but no person was found in that locality to make observations of river height. The section selected, near the mouth of the Verde River, appeared to be the only feasible locality, and gave fair results up to 4-foot rise of the water. At this stage the stream overflowed into back channels.

On August 26, 1889, measurements were begun on the Gila River about 18 miles above Florence, at a point where the river is confined between steep banks. At that time all of the rivers were low, but subject to fluctuations following rainfall upon the mountains. An examination was made of the Gila below the junction of the Salt as far as the Bend. The bed throughout continued of the same sandy character as above the junction, the water running in sloughs, forming innumerable sand bars in low water, and in time of flood spreading out to a width of from 1,000 to 3,000 feet.

Difficulty was experienced in obtaining observers at the points named, as the persons living sufficiently near to take observations were careless or neglected to make frequent readings of the gage. After a few months' experience it was decided that the only way by which accurate results could be obtained was to go into the mountains, locate stations near the lower end of suitable canyons, and employ a man to stay at the selected points. Later an attempt was made to establish a station below the junction of the Salt and Verde, about 1½ miles below Arizona Dam and 400 yards above the Highland Canal. The river banks at this point are about 13 feet above low water, and the channel during high water is 585 feet wide. On November 25 the attempt was made to put a cable across the river. Supports were built, and on December 4 the cable was about in place, when a sudden flood in the river, coming without warning, swept away the steel cable and supports and buried them under vast quantities of drift. Sudden storms of this character, known locally as "cloudbursts," are not unusual in this part of the country, and the streams are at all times liable to these fluctuations, rendering it impossible to make measurements from boats, as the current at such times is very rapid and large numbers of tree trunks and pieces of heavy drift wood are brought down.

In January, 1890, a river station was established on Gila River at Buttes, 15 miles above Florence, and attempts made to secure an accurate series of measurements. From observations taken at this point the mean daily discharge of the river was computed from August 26, 1889, to August 30, 1890. Occasional readings at a later date enabled computations to be made in December, 1890, and in January and February, 1891. From this camp on the Gila River, above Florence, measurements were made of the discharge of San Pedro River near Dudleyville, and of other streams.

At intervals during succeeding years Mr. Farish made a number of measurements of streams in Arizona, and he reports that during the summer of 1893 a series of observations were made on the Salt and Verde rivers. These measurements extend from May to September.

Daily mean gage height and discharge of the Verde River for 1893.

Day.	May.		June.		July.		August.	
	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
		Sec. feet.		*Sec. feet.*		*Sec. feet.*		*Sec. feet.*
1	.....	.....	3.60	.....	3.40	115	3.80	.....
2	.....	.....	3.60	.....	3.45	122	4.40	.....
3	.....	.....	3.60	.....	3.45	122	4.00	.....
4	.....	.....	3.60	.....	3.45	125	4.40	.....
5	.....	.....	3.60	225	3.45	129	4.00	.....
6	.....	.....	3.55	192	3.45	118	3.90	.....
7	.....	.....	3.50	167	3.50	131	4.50	.....
8	.....	.....	3.50	164	3.50	129	4.00	.....
9	.....	.....	3.50	159	3.50	127	3.90	.....
10	.....	.....	3.50	150	3.50	115	3.85	.....
11	.....	.....	3.55	171	3.50	133	3.80	.....
12	.....	.....	3.50	138	3.45	126	3.70	.....
13	.....	.....	3.50	146	3.55	167	3.70	.....
14	.....	.....	3.50	144	3.55	167	4.10	.....
15	.....	.....	3.50	167	3.50	121	4.00	.....
16	.....	.....	3.50	184	3.50	141	4.55	.....
17	.....	.....	3.50	169	3.50	141	5.50	.....
18	.....	.....	3.50	186	3.90	260	5.20	.....
19	.....	.....	3.45	147	4.40	288	5.20	.....
20	.....	.....	3.45	145	(*a*)	.....	5.15	.....
21	.....	.....	3.45	158	3.80	271	5.00	.....
22	.....	.....	3.45	153	4.10	.....	5.50	.....
23	3.70	.....	3.45	135	3.80	.....	5.20	.....
24	3.60	.....	3.50	146	4.10	.....	.....	.....
25	3.60	243	3.50	154	6.30	.....	.....	.....
26	3.65	234	3.50	159	5.40	.....	.....	.....
27	3.60	212	3.50	162	4.70	.....	.....	.....
28	3.60	.....	3.45	154	4.40	.....	.....	.....
29	3.60	217	3.45	145	4.10	.....	.....	.....
30	3.60	.....	3.40	132	4.00	.....	.....	.....
31	3.60	.....	.....	.....	3.85	.....	.....	.....

a Gage slipped.

YUMA STATION, ON COLORADO RIVER.

This station is located at the Southern Pacific Railroad bridge across the Colorado River at Yuma, Ariz. Records have been kept here since April, 1878. The locality was examined by Mr. Arthur P. Davis on January 17, 1895. The observer is the bridge watchman at Yuma. The gaging station is about 700 feet distant from the watchman's house. The gage is fastened to a tall pile about 100 feet east of the north end of the bridge. It is vertical, is divided into feet and inches from about 15 feet up, and at low water is dry, so that another gage, for low water, is placed on the west end of the southern pier, and can be read from the bank. Measurements of discharge were made from the same bridge. This is a fairly good cross section ordinarily, but at the time visited, on the above-named date, was broken up with false work for repairs then in progress. The computed discharge was 9,737 second-feet.

Daily gage height of Colorado River at Yuma, Arizona, for 1894.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	17.00	16.58	16.42	18.33	19.42	22.83	20.25	19.42	19.00	18.42	18.75	18.50
2	16.83	16.67	16.75	18.25	19.58	22.75	20.33	19.42	19.08	18.42	18.75	18.50
3	16.67	16.67	16.92	18.00	19.67	22.83	20.25	19.42	19.16	18.33	18.75	18.58
4	16.50	16.58	17.00	17.92	20.75	22.83	20.25	19.33	19.42	18.33	18.83	18.58
5	16.42	16.58	17.00	17.92	20.92	23.00	20.08	19.33	19.42	18.25	18.83	18.58
6	16.42	16.58	17.08	17.92	21.00	23.00	20.00	19.25	19.25	18.33	19.16	18.67
7	16.42	16.83	17.00	18.00	21.00	23.08	19.83	19.25	18.92	18.33	19.16	18.67
8	16.58	17.00	17.16	18.00	20.92	23.16	19.83	19.33	18.67	18.33	19.08	18.67
9	16.92	17.00	17.25	18.08	20.67	23.16	19.67	19.25	18.67	18.33	19.08	18.67
10	17.00	17.00	17.08	18.06	20.50	23.25	19.67	19.33	18.67	18.50	19.00	18.67
11	17.08	17.00	16.92	18.16	20.33	23.25	19.67	19.33	18.50	18.50	18.83	18.67
12	16.83	16.92	17.00	18.33	20.50	23.33	19.67	19.33	18.67	18.42	18.83	18.67
13	16.92	16.92	16.92	18.50	20.83	23.58	19.83	19.25	18.08	18.50	18.75	18.67
14	16.83	16.83	16.92	18.42	21.50	23.67	20.25	19.33	18.67	18.67	18.58	18.83
15	16.58	16.83	16.92	18.33	21.08	23.67	20.16	19.25	18.58	18.67	18.58	18.83
16	16.42	16.75	16.92	18.00	22.42	23.33	19.83	19.42	18.67	18.58	18.58	18.83
17	16.25	16.92	17.00	18.00	22.50	23.00	19.67	19.16	18.50	18.58	18.58	18.92
18	16.16	16.83	16.92	18.00	22.58	22.67	19.75	19.25	18.42	18.58	18.50	18.83
19	16.00	16.83	17.25	18.00	22.75	22.25	19.75	19.25	18.67	18.58	18.50	18.92
20	15.92	16.75	17.42	18.33	23.08	22.16	19.50	19.16	18.67	18.50	18.58	18.83
21	15.83	16.83	17.33	18.25	23.25	21.83	19.42	19.00	18.50	18.67	18.58	18.75
22	15.83	16.83	17.25	18.16	23.42	21.67	19.33	19.00	18.50	18.67	18.58	18.67
23	15.83	16.83	17.25	18.16	23.33	21.50	19.33	18.83	18.67	18.67	18.50	18.67
24	15.83	16.75	17.25	18.50	23.16	21.16	19.50	18.83	18.58	18.58	18.58	18.75
25	15.92	16.67	17.58	18.83	23.00	21.00	19.67	18.75	18.58	18.67	18.67	18.75
26	16.00	16.58	18.42	19.08	23.08	20.75	19.67	18.75	18.50	18.67	18.58	18.67
27	16.25	16.58	18.33	19.50	23.16	20.58	19.50	18.75	18.42	18.75	18.58	19.08
28	16.33	16.50	18.16	19.33	23.33	20.50	19.58	18.92	18.42	18.75	18.50	19.00
29	16.42	.....	18.08	19.42	23.42	20.25	19.67	19.00	18.42	18.75	18.50	18.92
30	16.58	.....	18.16	19.33	23.16	20.16	19.50	19.16	18.33	18.75	18.50	18.80
31	16.58	.....	18.33	.....	23.08	.....	19.42	19.25	.....	18.75	.....	.....

INTERIOR BASIN, IN NEVADA, UTAH, AND IDAHO.

This great basin includes an area of 216,872 square miles, mainly in the State of Nevada, extending southerly into California, easterly into Utah, and northerly into Idaho and Oregon. The principal rivers are upon the east, in Utah, draining the Wasatch Mountains, and ultimately losing their waters in the Great Salt Lake. On the west are the rivers flowing down the steep easterly slope of the high Sierra Nevada, and in the center of the basin is the Humboldt. In the past a considerable number of measurements have been made upon the rivers of Utah and Nevada, and during 1893 and 1894 a few of the river stations previously established were maintained and others were located. In the following pages figures and descriptions are given briefly for the station at Golconda, on the Humboldt; at Battle Creek and Collinston, on the Bear, and at Uintah, Provo, and Leamington, in Utah.

GOLCONDA STATION, ON HUMBOLDT RIVER.

This station is located near Golconda, Humboldt County, Nev., being distant from the home of the observer, Mr. L. Dutertre about $1\frac{3}{4}$ miles. The gage is a pine board, inclined, firmly spiked to posts driven well into the bank, and graduated to feet and tenths. The river channel is through earth; the banks are steep and moderately stable, and the channel is almost straight for 400 or 500 feet. The bed of the channel is of sand and gravel. There are two bench marks on the west side

of the river. One is on a hub 2 by 4 inches, about 20 feet from the gage. This hub is flush with the surface of the ground, is driven 2.5 feet, and is 10.55 feet above zero of the gage. The second is on a heavy spike driven into the side of an 8 by 8 inch post, to which the west end of the heavy wire across the river is fastened. This post is set 3.5 feet in the ground. The elevation of this bench mark is 13.70 feet above zero of the gage.

BATTLE CREEK STATION, ON BEAR RIVER.

Measurements of Bear River were begun at this place on October 11, 1889, a station being established by Mr. T. M. Bannon near the point where the Utah and Northern Railroad formerly crossed the river and turned northwesterly on the way to Pocatello, Idaho. This locality is below the canyons and above Cache Valley, being about 10 miles north of the Utah-Idaho boundary. The name is from that of a small creek which enters Bear River from the right-hand side. Computations of discharge at this point give the quantity of water coming from Idaho into Utah through Bear River, this being available for use at points below. No canals are taken from the river itself for a considerable distance above, though the waters of several of the tributaries are diverted in southern Idaho.

A number of discharge measurements were made during 1890 and 1891, furnishing data for a rating curve for this station as given below. This has not been verified for 1893 and 1894, so that its applicability is in doubt. The bench marks as originally established are as follows: No. 1 is on the west end of cap of first bent of piling of approach on west side of river, and is 10.54 feet above zero of gage. No. 2 is on the southeast corner of the house of Mr. John Murdoch, the observer, about 1½ feet from the ground, on the fourth log. It is 10.95 feet above zero. The gage is nailed to one of the bridge piers, and the cable is 200 feet west.

On April 29, 1891, Mr. Frank Tweedy established a new bench mark in the forks of a double lone cottonwood tree on the north side of the river, about 100 feet from the bank of the river, and 200 feet above the railroad bridge. This is 8.90 feet above zero of gage.

The station was inspected on October 29, 1894, by Mr. Arthur P. Davis. He found the cable too slack for use in measuring and the tag wire missing. The latter he replaced by using 250 feet of barbed wire, and after tightening up the cable made a discharge measurement from a suspended box, obtaining for a height of 1.90 feet a quantity of 980 second-feet.

Rating table for Bear River at Battle Creek, Idaho.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
	Sec. feet.		*Sec. feet.*		*Sec. feet.*		*Sec. feet.*
1.00	350	2.10	1,420	3.20	2,870	4.30	5,030
1.10	430	2.20	1,540	3.30	3,030	4.40	5,260
1.20	510	2.30	1,660	3.40	3,200	4.50	5,500
1.30	600	2.40	1,780	3.50	3,380	4.60	5,740
1.40	690	2.50	1,910	3.60	3,570	4.70	5,980
1.50	780	2.60	2,040	3.70	3,760	4.80	6,230
1.60	880	2.70	2,170	3.80	3,960	4.90	6,480
1.70	980	2.80	2,300	3.90	4,160	5.00	6,730
1.80	1,090	2.90	2,440	4.00	4,370		
1.90	1,200	3.00	2,580	4.10	4,590		
2.00	1,310	3.10	2,720	4.20	4,810		

Daily gage height of Bear River at Battle Creek, Idaho, for 1893.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.60	1.70	1.50	2.10	3.10	3.60	3.10	1.60	1.40	1.40	1.60	1.80
2	1.60	1.70	1.50	2.20	3.10	3.60	3.00	1.50	1.40	1.40	1.60	1.80
3	1.60	1.70	1.50	2.20	3.20	3.60	3.00	1.50	1.40	1.40	1.60	.....
4	1.60	1.70	1.50	2.30	3.20	3.70	2.90	1.50	1.40	1.40	1.60	.....
5	1.60	1.70	1.50	2.40	3.20	3.70	2.80	1.50	1.40	1.40	1.60	.....
6	1.60	1.70	1.50	2.45	3.20	3.70	2.70	1.50	1.40	1.40	1.60	.....
7	1.60	1.70	1.50	2.50	3.20	3.70	2.70	1.50	1.40	1.40	1.60	.....
8	1.60	1.70	1.50	2.50	3.25	3.80	2.60	1.50	1.40	1.40	1.60	.....
9	1.60	1.70	1.50	2.50	3.30	3.80	2.50	1.50	1.40	1.40	1.60	.....
10	1.60	1.70	1.50	2.50	3.30	3.80	2.50	1.50	1.40	1.40	1.60	1.80
11	1.60	1.70	1.50	2.60	3.30	3.80	2.40	1.50	1.40	1.40	1.60	1.80
12	1.60	1.70	1.50	2.60	3.40	3.80	2.30	1.50	1.40	1.40	1.60	1.70
13	1.60	1.60	1.50	2.60	3.40	3.70	2.30	1.50	1.40	1.40	1.60	1.70
14	1.60	1.60	1.50	2.60	3.40	3.70	2.20	1.50	1.40	1.40	1.60	1.70
15	1.60	1.50	1.50	2.60	3.40	3 60	2.20	1.50	1.40	1.40	1.60	1.70
16	1.60	1.50	1.50	2.60	3.50	3.60	2.10	1.50	1.40	1.40	1.60	1.70
17	1.60	1.50	1.50	2.60	3.50	3.60	2.10	1.50	1.40	1.50	1.60	1.70
18	1.60	1.50	1.50	2.60	3.60	3.60	2.00	1.50	1.40	1.50	1.60	1.70
19	1.60	1.50	1.50	2.70	3.70	3.60	2.00	1.50	1.40	1.50	1.60	1.70
20	1.60	1.50	1.50	2.80	3.70	3.60	1.90	1.50	1.40	1.50	1.60	1.70
21	1.60	1.50	1.50	2.85	3.70	3.60	1.90	1.50	1.40	1.50	1.60	1.70
22	1.60	1.50	1.50	2.90	3.80	3.60	1.80	1.50	1.40	1.50	1.60	1.70
23	1.70	1.50	1.60	2.90	3.80	3.60	1.80	1.50	1.40	1.50	1.60	1.70
24	1.70	1.50	1.60	3.00	3.80	3.60	1.80	1.50	1.40	1.50	1.60	1.70
25	1.70	1.50	1.60	3.00	3.80	3.50	1.70	1.50	1.40	1.50	1.60	1.70
26	1.70	1.50	1.60	3.00	3.80	3.40	1.70	1.50	1.40	1.50	1.60	1.70
27	1.70	1.50	1.70	3.00	3.80	3.40	1.70	1.50	1.40	1.50	1.60	1.70
28	1.70	1.50	1.90	3.10	3.80	3.30	1.60	1.40	1.40	1.50	1.70	1.70
29	1.70	.....	1.90	3.10	3.80	3.20	1.60	1.40	1.40	1.50	1.70	1.70
30	1.70	.....	2.00	3.10	3.70	3.20	1.60	1.40	1.40	1.50	1.70	1.70
31	1.70	.....	2.00	.....	3.70	.....	1.60	1.40	.....	1.60	.....	1.70

Daily gage height of Bear River at Battle Creek, Idaho, for 1894.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.70	*a* 1.70	1.70	2.80	3.90	5.50	3.30	2.10	1.80	2.00	1.90	1.80
2	1.70	1.70	1.80	3.10	3.90	5.50	3.20	2.00	1.80	2.00	1.90	1.80
3	1.70	1.70	1.80	3.40	3.90	5.50	3.10	2.00	1.80	2.00	1.90	1.70
4	1.70	1.70	1.80	3.70	4.00	5.50	3.00	2.00	1.90	2.00	1.90	1.70
5	1.70	1.70	1.80	3.90	4.00	5.50	2.90	2.00	1.90	2.00	1.90	1.70
6	1.70	1.70	1.90	4.10	4.10	5.40	2.80	2.00	2.00	2.00	1.90	1.70
7	1.70	1.70	1.90	4.40	4.10	5.40	2.70	2.00	2.10	2.00	1.90	1.70
8	1.70	1.70	1.90	4.40	4.20	5.40	2.70	2.00	2.10	2.00	1.90	1.70
9	1.70	1.70	1.90	4.40	4.20	5.40	2.70	2.00	2.10	2.00	1.90	1.70
10	1.70	1.70	1.90	4.20	4.30	5.40	2.70	1.90	2.10	2.00	1.90	1.70
11	1.70	1.70	1.90	4.00	4.40	5.33	2.60	1.90	2.00	2.00	1.90	1.70
12	1.70	1.70	2.00	3.80	4.50	5.33	2.60	1.90	2.00	1.90	1.90	1.70
13	1.70	1.70	2.10	3.50	4.50	5.20	2.60	1.90	2.00	1.90	1.80	1.70
14	1.70	1.70	2.10	3.50	4.50	5.10	2.60	1.90	2.00	1.90	1.80	1.70
15	1.70	1.70	2.10	3.50	4.60	5.00	2.60	1.80	2.00	1.90	1.80	1.70
16	1.70	1.70	2.00	3.50	4.60	4.90	2.50	1.80	2.00	1.90	1.80	1.70
17	1.70	1.70	2.00	3.50	4.70	4.80	2.50	1.80	2.00	1.90	1.80	1.70
18	1.70	1.70	2.00	3.50	4.70	4.70	2.50	1.80	2.00	1.90	1.80	1.70
19	1.70	1.70	2.10	3.50	4.80	4.60	2.50	1.80	2.00	1.90	1.80	1.70
20	1.70	1.70	2.10	3.50	4.90	4.40	2.40	1.80	2.00	1.90	1.80	1.70
21	1.70	1.70	2.20	3.60	4.90	4.30	2.40	1.80	2.00	1.90	1.88	1.70
22	1.70	1.70	2.10	3.60	5.00	4.20	2.40	1.80	2.00	1.90	1.80	1.70
23	1.70	1.70	2.00	3.60	5.10	4.10	2.30	1.80	2.00	1.90	1.80	1.70
24	1.70	1.70	1.90	3.70	5.20	4.00	2.30	1.80	2.00	1.90	1.80	1.70
25	1.70	1.70	2.00	3.70	5.30	3.90	2.30	1.80	2.00	1.90	1.80	1.70
26	1.70	1.70	2.10	3.80	5.30	3.80	2.30	1.80	2.00	1.90	1.80	1.70
27	1.70	1.70	2.20	3.80	5.30	3.75	2.20	1.80	2.00	1.90	1.80	1.70
28	1.70	1.70	2.30	3.80	5.30	3.65	2.20	1.80	2.00	1.90	1.80	1.70
29	1.70	.....	2.40	3.80	5.40	3.50	2.20	1.80	2.00	1.90	1.80	1.70
30	1.70	.....	2.50	3.80	5.40	3.35	2.10	1.80	2.00	1.90	1.80	1.70
31	1.70	.....	2.60	.....	5.50	.....	2.10	1.80	.....	1.90	.....	1.70

a Frozen.

COLLINSTON STATION, ON BEAR RIVER.

This station is situated at the lower end of the canyon below the Cache Valley, Utah, and about 7 miles from the railroad station of Collinston, on the Utah and Northern Railroad. It was established in July, 1889, by Mr. T. M. Bannon, the object being to obtain the total amount of water available for use in the irrigation of the extensive tracts of land lying to the north and northwest of Great Salt Lake. The locality is a short distance below the headworks of the Bear River Canal, the observations being kept by the watchman employed by that company. As originally established the inclined gage was referred to bench marks, one of these being on a telegraph pole 50 feet north of the cable and consisting of a staple driven into the pole. This is 8.84 feet above the zero of the gage. A second bench mark is on a stake driven into the ground directly back of the anchor on the cable on the west side and surrounded by rocks. It is 12.77 feet above zero of the gage.

This station was inspected on October 6, 1894, by Prof. Samuel Fortier, who reports that the old bench marks had been removed. He established two new bench marks. One consists of two nails in a notch on the northeast corner of the house, in the corner boards, about 2.3 feet above the ground. The elevation of this point was 7.24 feet above the 5-foot mark of the gage. No. 2 is on a nail in an oak stake 2 by 3 inches, placed 20 feet west of the 8-foot mark of the gage

and 20 feet north of the cable. The elevation is 2.35 feet above the 5-foot mark of the gage. The gage was found to be apparently solid, but it was evident that the ice around the lower portion had lifted that end, necessitating a correction in the original markings. The changes at this point due to ice in the river necessitate the construction of a different form of gage in order to give comparable readings. The following table gives the heights of river as reported by the observer:

Daily gage height of Bear River at Collinston, Utah, for 1893.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1.....	2.10	2.10	1.90	3.50	4.10	4.90	4.05	1.90	1.60	1.90	2.10	2.40
2.....	2.05	2.15	1.90	3.55	4.10	4.85	4.00	1.90	1.60	1.90	2.10	2.40
3.....	2.00	2.10	1.80	3.80	4.20	4.80	3.90	2.00	1.60	1.90	2.20	2.40
4.....	2.10	2.00	1.80	3.90	4.20	4.90	3.80	2.00	1.60	2.00	2.20	2.40
5.....	2.10	2.25	1.90	4.00	4.40	4.70	3.70	1.90	1.60	2.00	2.20	2.30
6.....	2.10	2.15	1.90	4.20	4.30	4.60	3.60	1.90	1.60	2.00	2.20	2.30
7.....	2.10	2.20	1.80	4.20	4.30	4.50	3.50	1.80	1.70	1.90	2.20	2.20
8.....	2.10	2.30	1.70	4.10	4.30	4.60	3.50	1.80	1.70	1.90	2.10	2.20
9.....	2.00	2.20	1.70	3.90	4.40	4.60	3.30	1.80	1.70	1.90	2.10	2.20
10.....	2.00	2.20	1.80	3.90	4.40	4.70	3.10	1.70	1.70	1.90	2.10	2.20
11.....	2.10	2.00	1.80	4.10	4.50	4.90	3.00	1.70	1.70	2.00	2.10	2.20
12.....	2.10	1.90	1.80	4.20	4.70	4.90	2.90	1.60	1.70	2.00	2.10	2.30
13.....	2.00	1.90	1.90	4.30	4.80	5.00	2.80	1.60	1.70	2.00	2,00	2.30
14.....	2.00	1.85	1.90	4.30	4.90	5.00	2.70	1.60	1.70	2.00	2.00	2.30
15.....	2.00	1.80	2.00	4.30	5.15	5.10	2.70	1.70	1.70	2.00	2.00	2.30
16.....	2.00	1.80	2.00	4.15	5.25	5.10	2.60	1.70	1.70	1.90	2.00	2.30
17.....	2.00	1.90	2.10	4.00	5.40	5.00	2.60	1.70	1.70	1.90	2.00	2.30
18.....	2.00	1.80	2.20	3.85	5.55	5.05	2.50	1.70	1.70	2.00	2.00	2.20
19.....	2.10	1.70	2.20	3.80	5.75	5.10	2.50	1.60	1.70	2.00	2.00	2.10
20.....	2.10	1.70	2.30	3.80	5.95	5.00	2.40	1.60	1.70	2.00	2.00	2.10
21.....	2.10	1.70	2.40	3.70	6.00	4.90	2.40	1.60	1.70	2.00	2.00	2.10
22.....	2.00	1.80	2.50	3.70	6.05	4.80	2.40	1.70	1.70	2.00	2.00	2.00
23.....	2.00	1.80	2.60	3.75	5.95	4.70	2.30	1.70	1.80	2.00	2.00	2.00
24.....	2.00	1.80	2.70	3.75	5.80	4.60	2.30	1.70	1.80	2.00	2.00	1.90
25.....	2.00	1.90	2.80	4.00	5.55	4.60	2.30	1.60	1.80	2.00	2.00	1.90
26.....	2.10	1.90	2.90	4.10	5.40	4.50	2.20	1.60	1.80	2.00	2.10	1.80
27.....	2.10	1.90	3.00	4.15	5.20	4.40	2.20	1.60	1.80	2.10	2.10	1.80
28.....	2.10	1.80	3.10	4.30	4.75	4.30	2.10	1.70	1.80	2.10	2.20	1.80
29.....	2.05	.....	3.20	4.25	4.65	4.20	2.10	1.60	1.90	2.10	2.30	1.80
30.....	2.10	.....	3.30	4.15	4.60	4.10	2.00	1.60	1.90	2.10	2.30	1.80
31.....	2.00	.....	3.40	.....	4.60	.....	2.00	1.60	.....	2.10	.....	1.80

Daily gage height of Bear River at Collinston, Utah, for 1894.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.80	1.90	1.90	5.00	5.40	6.90	4.50	2.00	1.80	2.10	2.10	2.00
2	1.70	1.90	1.80	4.90	5.50	6.90	4.30	2.00	1.70	2.10	2.10	2.00
3	1.70	1.80	1.80	5.00	5.40	7.00	4.00	2.00	1.80	2.20	2.10	2.00
4	1.70	1.90	1.90	5.00	5.30	7.00	3.90	1.90	1.80	2.20	2.00	2.00
5	1.70	1.90	1.90	5.10	5.30	7.00	3.70	2.00	1.80	2.20	2.00	2.00
6	1.70	1.90	1.80	5.20	5.20	6.90	3.60	2.00	1.90	2.10	2.00	2.00
7	1.80	1.90	1.80	5.30	5.20	6.80	3.60	2.00	1.90	2.20	1.90	2.00
8	1.70	1.90	1.90	5.30	5.30	6.80	3.50	1.90	1.90	2.20	1.90	2.00
9	1.70	1.80	1.90	5.30	5.50	6.70	3.50	1.90	1.80	2.20	1.90	.....
10	1.70	1.80	1.90	5.40	5.60	6.60	3.40	1.90	2.00	2.20	1.90	.....
11	1.80	1.80	2.00	5.40	5.70	6.50	3.30	1.90	2.00	2.10	2.00	.....
12	1.80	1.80	2.20	5.30	5.80	6.40	3.30	1.70	2.00	2.10	2.00	.....
13	1.80	1.90	2.40	5.30	5.80	6.20	3.20	1.70	1.90	2.10	2.00	.....
14	1.90	1.90	2.50	5.20	5.90	6.20	3.00	1.70	1.90	2.10	2.00	.....
15	1.90	1.80	2.70	5.30	6.00	6.10	3.00	1.70	1.80	2.10	2.00	.....
16	1.90	1.90	2.70	5.20	6.10	6.00	3.00	1.60	1.90	2.10	2.00	2.00
17	1.80	1.90	2.80	5.20	6.30	.....	2.90	1.60	1.90	2.00	1.90	2.00
18	1.80	1.80	2.80	5.00	6.30	5.80	2.80	1.60	2.00	2.00	1.90	2.00
19	1.90	1.80	2.90	4.80	6.40	5.70	2.70	1.60	2.00	2.00	1.90	2.00
20	1.90	1.90	3.00	4.70	6.20	5.50	2.60	1.60	2.10	2.10	1.90	1.90
21	1.90	1.80	3.10	4.60	6.10	5.40	2.50	1.60	2.20	2.10	1.90	1.90
22	1.90	1.80	3.10	4.70	6.20	5.20	2.60	1.60	2.30	2.10	1.90	1.90
23	1.80	1.80	3.10	4.80	6.40	5.10	2.60	1.60	2.20	2.10	1.90	2.00
24	1.80	1.80	3.00	4.90	6.40	4.90	2.50	1.60	2.20	2.10	1.90	2.00
25	1.80	1.80	3.40	4.90	6.50	4.80	2.40	1.60	2.10	2.00	1.90	2.00
26	1.90	1.80	3.60	5.00	6 50	4.70	2.40	1.60	2.10	2.00	1.90	2.00
27	1.90	1.90	3.80	5.10	6.50	4.60	2.30	1.70	2.00	2.00	1.90	2.10
28	1.90	1.90	4.00	5.30	6.60	4.60	2.20	1.60	2.00	2.00	1.90	2.10
29	1.80	.....	4.30	5.40	6.70	4.60	2.10	1.70	2.00	2.00	2.00	2.10
30	1.80	.....	4.60	5.50	6.80	4.40	2.10	1.70	2.00	2.00	2.00	2.00
31	1.80	.....	4.80	.....	6.90	.....	2.10	1.70	.....	2.00	.....	2.00

UINTA STATION, ON WEBER RIVER.

This station is near Devils Gate, on the Union Pacific Railroad, in Weber Canyon, about 12 miles east of Ogden City. The nearest railroad station is Uinta, about 3 miles below Devils Gate. The locality is highly favorable for stream measurements, the channel of the river being straight for a short distance both above and below the section at which observations are made. The banks are perpendicular on both sides. The bottom is gravelly and does not change appreciably. The section is 110 feet wide, 0.7 to 0.9 foot deep in low water with a velocity of from 1.5 to 2 feet per second in low water, and from 8 to 10 feet per second during flood. This station is above the head of the canals diverting water to cover the land south and west of Ogden. The first measurements were made August 12, 1889, the station being established in October following. Observations were maintained until the end of 1893, when they were discontinued for lack of funds. On July 20, 1894, they were taken up again by Prof. Samuel Fortier and continued through that year. The station was refitted in October, 1894, and measurements made for the purpose of constructing a rating table.

Rating table of Weber River at Devils Gate, Utah.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
	Sec. feet.		*Sec. feet.*		*Sec. feet.*		*Sec. feet.*
1.00	240	2.40	1,220	3.80	2,520	5.20	4,040
1.10	290	2.50	1,310	3.90	2,620	5.30	4,160
1.20	340	2.60	1,400	4.00	2,720	5.40	4,280
1.30	395	2.70	1,490	4.10	2,825	5.50	4,405
1.40	450	2.80	1,580	4.20	2,930	5.60	4,530
1.50	520	2.90	1,670	4.30	3,035	5.70	4,655
1.60	590	3.00	1,760	4.40	3,140	5.80	4,780
1.70	665	3.10	1,850	4.50	3,250	5.90	4,905
1.80	740	3.20	1,940	4.60	3,360	6.00	5,030
1.90	815	3.30	2,035	4.70	3,470	6.10	5,755
2.00	890	3.40	2,130	4.80	3,580	6.20	5,280
2.10	970	3.50	2,225	4.90	3,690	6.30	5,405
2.20	1,050	3.60	2,320	5.00	3,800	6.40	5,530
2.30	1,135	3.70	2,420	5.10	3,920		

Daily gage height of Weber River above Uinta, Utah, for 1893.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1.....	1.80	0.90	0.90	3.50	3.50	5.00	2.30	0.30	0.20	0.20	0.40	2.00
2.....	1.40	.90	.90	3.80	3.50	5.20	2.00	.20	.20	.30	.40	2.00
3.....	1.30	.90	.90	4.00	3.60	5.00	1.80	.20	.20	.40	.40	1.60
4.....	1.20	.90	.90	4.20	3.70	5.00	1.60	.20	.20	.40	.40	1.20
5.....	1.10	.90	.90	4.00	3.80	4.80	1.40	.20	.20	.40	.40	1.00
6.....	1.10	.90	.90	3.60	3.80	4.60	1.00	.10	.20	.40	.40	.90
7.....	1.10	.90	.90	3.20	4.00	4.40	1.00	.10	.20	.40	.40	.90
8.....	1.10	.90	.90	2.80	4.20	4.60	.90	.10	.20	.40	.40	.90
9.....	1.10	.90	.90	2.00	4.40	4.80	1.00	.....	.20	.40	.40	.90
10.....	1.00	.90	.90	1.80	4.80	5.00	1.20	.....	.20	.40	.40	.80
11.....	1.00	.90	.90	1.50	5.00	5.50	1.40	.....	.20	.40	.40	.70
12.....	1.00	.90	1.00	1.00	5.20	5.40	1.40	.....	.20	.40	.40	.70
13.....	1.00	.90	1.20	1.00	5.20	5.50	1.40	.....	.20	.40	.40	.70
14.....	1.00	.90	1.40	1.00	6.00	5.40	1.40	.....	.20	.40	.40	.70
15.....	1.00	.90	1.80	1.00	6.80	5.60	1.30	.....	.20	.40	.40	.70
16.....	1.00	.90	1.90	1.40	7.50	5.00	1.20	.....	.20	.40	.40	.70
17.....	1.00	.90	1.90	1.60	7.80	4.40	1.00	.....	.20	.40	.40	.70
18.....	1.00	.90	2.00	2.00	7.20	4.20	.90	.10	.20	.40	.40	.70
19.....	1.00	.90	2.10	2.10	6.40	4.00	.80	.10	.20	.40	.40	.60
20.....	.90	.90	2.40	2.30	5.70	3.80	.70	.....	.20	.40	.40	.50
21.....	.90	.90	2.40	2.50	5.40	3.60	.50	.....	.20	.40	.50	.50
22.....	.90	.90	2.60	2.70	5.00	3.40	.40	.10	.20	.40	.60	.50
23.....	.90	.90	2.60	2.90	4.80	3.30	.50	.20	.20	.40	.70	.50
24.....	.90	.90	2.80	3.60	4.60	3.10	.50	.20	.20	.40	.80	.50
25.....	.90	.90	2.90	4.00	4.20	2.90	.50	.10	.20	.40	.80	.50
26.....	.90	.90	3.00	4.50	4.10	2.80	.40	.10	.20	.40	1.00	.50
27.....	.90	.90	3.20	4.00	4.00	2.50	.40	.20	.20	.40	1.00	.50
28.....	.90	.90	3.40	3.60	4.20	2.40	.40	.20	.20	.40	1.00	.50
29.....	.90	.....	3.40	3.40	4.40	2.40	.40	.20	.20	.40	1.00	.50
30.....	.90	.....	3.40	3.40	4.60	2.30	.30	.20	.20	.40	1.80	.50
31.....	.90	.....	3.50	.....	4.80	.....	.30	.20	.....	.40	.....	.50

Daily gage height of Weber River at Devils Gate, above Uinta, Utah, for 1894.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1.....	.....	0.50	0.80	1.10	1.00	0.90	17.....	.....	0.40	1.10	1.00	1.00	1.00
2.....	.....	.50	1.20	1.20	1.00	1.00	18.....	.....	.40	1.20	1.00	1.00	1.00
3.....	.....	.50	1.20	1.20	1.10	1.00	19.....	.....	.50	1.10	1.00	1.00	1.00
4.....	.....	.50	1.20	1.20	1.10	.80	20.....	1.10	.60	1.10	1.00	.90	1.00
5.....	.....	.40	1.20	1.20	1.00	.80	21.....	1.00	.60	1.00	1.10	.90	1.00
6.....	.....	.50	1.20	1.10	1.00	.80	22.....	.90	.70	1.00	1.10	.90	1.00
7.....	.....	.50	1.10	1.10	1.10	.80	23.....	.90	.80	1.00	1.10	.90	1.00
8.....	.....	.50	1.10	1.10	1.10	.80	24.....	.90	.80	1.00	1.00	.90	1.00
9.....	.....	.50	1.10	1.10	1.00	.80	25.....	.90	.80	.90	1.00	1.00	1.00
10.....	.....	.50	1.20	1.10	1.00	.90	26.....	.90	.80	.90	1.10	1.00	1.00
11.....	.....	.50	1.10	1.00	1.00	.90	27.....	.80	.80	.90	1.10	1.00	1.00
12.....	.....	.40	1.10	1.00	1.00	.90	28.....	.80	.80	1.00	1.20	1.00	1.00
13.....	.....	.40	1.20	1.00	1.00	.80	29.....	.70	.80	1.00	1.10	1.00	1.00
14.....	.....	.40	1.20	1.00	1.00	.90	30.....	.70	.80	1.00	1.10	1.00	1.00
15.....	.....	.50	1.10	1.00	.90	.90	31.....	.60	.80	.....	1.10	.....	1.00
16.....	.....	.50	1.00	1.00	1.00	.90							

PROVO STATION, ON PROVO RIVER.

The Provo River, rising in the Wasatch Mountains, southeasterly from Salt Lake City, Utah, flows westerly through open valleys, and finally cuts a deep canyon, discharging upon the lands east of Utah Lake. Near and below the mouth of the canyon its waters are diverted by numerous canals on both sides of the stream. A gaging station was established in the canyon above the heads of these canals, at a point about 6 miles from Provo City, observations being begun on July 27, 1889. The channel at this point is nearly straight for several hundred feet; the bottom of the river is rocky and does not appear to change. The bank on the north side is sufficiently high to confine all of the waters, but on the south side a rise of 2 feet above low water causes the stream to spread over a rocky bar. Measurements can be made with great accuracy during low water, but at times of flood the results are not so good. The station is equipped with a cable, tag wire, and boat, from which measurements are made. The gage is inclined. The bench mark is on a stone firmly bedded in a bank near the wagon road, about 100 feet southwest of the gage. It is marked "B. M." in black paint, and is 6.95 feet above the zero of the gage. This station was inspected on October 24 by Mr. Arthur P. Davis, who found for a gage height of 4.38 a discharge of 338 second-feet. The observer lives at some distance from this point, and there are some doubts whether his readings of heights are entirely reliable. They are given as reported, together with the rating table constructed from measurements made in preceding years.

Rating table of Provo River at Provo, Utah.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
	Sec. feet.		*Sec. feet.*		*Sec. feet.*		*Sec. feet.*
3.70	144	4.70	564	5.70	1,316	6.70	2,100
3.80	154	4.80	630	5.80	1,394	6.80	2,180
3.90	174	4.90	700	5.90	1,470	6.90	2,260
4.00	200	5.00	774	6.00	1,550	7.00	2,340
4.10	240	5.10	851	6.10	1,626	7.10	2,420
4.20	280	5.20	928	6.20	1,704	7.20	2,500
4.30	330	5.30	1,006	6.30	1,780	7.30	2,580
4.40	380	5.40	1,084	6.40	1,860	7.40	2,660
4.50	440	5.50	1,160	6.50	1,940		
4.60	500	5.60	1,240	6.60	2,020		

Daily gage height of Provo River above Provo, Utah, for 1893.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.20	4.10	4.20	5.20	4.70	5.80	5.00	4.20	4.10	4.20	4.40	4.40
2	4.20	4.10	4.20	5.00	4.70	6.10	5.30	4.20	4.10	4.20	4.40	4.40
3	4.20	4.10	4.20	5.20	4.70	6.30	5.20	4.20	4.10	4.20	4.40	4.50
4	4.20	4.10	4.20	5.20	4.70	6.30	4.90	4.20	4.10	4.20	4.40	4.50
5	4.20	4.10	4.20	5.20	4.70	6.40	4.80	4.20	4.10	4.20	4.40	4.50
6	4.20	4.10	4.20	5.10	4.80	6.60	4.70	4.20	4.10	4.20	4.40	4.50
7	4.20	4.20	4.20	5.10	5.00	6.70	4.60	4.20	4.10	4.20	4.40	4.50
8	4.20	4.20	4.20	5.00	5.10	6.80	4.40	4.10	4.10	4.20	4.40	4.50
9	4.20	4.20	4.20	4.90	5.20	6.80	4.30	4.10	4.10	4.30	4.40	4.50
10	4.10	4.20	4.20	4.80	5.30	6.90	4.30	4.10	4.10	4.30	4.40	4.50
11	4.10	4.20	4.20	4.70	5.40	6.80	4.30	4.10	4.10	4.30	4.40	4.50
12	4.10	4.20	4.20	4.70	5.40	6.60	4.30	4.10	4.10	4.30	4.40	4.50
13	4.10	4.20	4.20	4.60	5.50	6.40	4.30	4.10	4.10	4.40	4.40	4.50
14	4.10	4.20	4.20	4.50	5.80	6.40	4.30	4.10	4.10	4.40	4.40	4.50
15	4.10	4.20	4.20	4.40	6.00	6.50	4.30	4.10	4.10	4.40	4.40	4.40
16	4.10	4.20	4.20	4.50	6.40	6.40	4.30	4.10	4.10	4.40	4.40	4.40
17	4.10	4.20	4.20	4.50	6.70	6.30	4.30	4.10	4.20	4.40	4.40	4.40
18	4.10	4.20	4.20	4.50	7.00	6.10	4.20	4.10	4.20	4.40	4.40	4.40
19	4.10	4.20	4.20	4.50	6.70	5.90	4.20	4.10	4.20	4.40	4.40	4.40
20	4.10	4.20	4.20	4.50	6.60	5.70	4.20	4.10	4.20	4.40	4.40	4.40
21	4.10	4.20	4.30	4.40	6.10	5.70	4.20	4.10	4.20	4.40	4.40	4.40
22	4.10	4.20	4.30	4.40	5.90	5.50	4.20	4.10	4.20	4.40	4.40	4.40
23	4.10	4.20	4.40	4.50	5.80	5.50	4.20	4.10	4.20	4.40	4.40	4.50
24	4.10	4.20	4.40	4.80	5.70	5.40	4.20	4.10	4.20	4.40	4.40	4.50
25	4.10	4.20	4.30	4.90	5.60	5.40	4.20	4.10	4.20	4.40	4.40	4.50
26	4.10	4.20	4.40	5.20	5.50	5.40	4.20	4.10	4.20	4.40	4.40	4.50
27	4.10	4.20	4.60	5.10	5.50	5.20	4.20	4.10	4.20	4.40	4.50	4.50
28	4.10	4.20	4.60	5.00	5.60	5.20	4.20	4.10	4.20	4.40	4.50	4.40
29	4.10	.....	4.60	4.70	5.70	5.00	4.20	4.10	4.20	4.40	4.50	4.40
30	4.10	.....	4.90	4.70	5.70	5.00	4.20	4.10	4.20	4.40	4.50	4.40
31	4.10	.....	5.00	.....	5.80	.....	4.20	4.10	.....	4.40	.....	4.40

Daily gage height of Provo River above Provo, Utah, for 1894.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.40	4.40	4.50	4.70	5.30	6.50	4.50	4.10	4.10	.....	4.50	4.30
2	4.40	4.40	4.50	4.70	5.20	6.50	4.50	4.10	4.40	.....	4.40	4.30
3	4.40	4.40	4.50	4.70	5.10	.....	4.30	4.10	4.40	.....	4.40	4.30
4	4.40	4.40	4.50	4.70	5.10	.....	4.30	4.10	4.40	.....	4.40	4.30
5	4.40	4.40	4.50	4.70	5.10	.....	4.50	4.10	4.40	.....	4.40	4.30
6	4.40	4.40	4.50	4.70	5.10	.....	4.40	4.10	4.50	.....	4.40	4.30
7	4.40	4.40	4.50	4.70	5.20	.....	4.50	4.10	4.50	.....	4.40	4.30
8	4.40	4.40	4.50	4.60	5.40	.....	4.30	4.10	4.50	.....	4.40	4.30
9	4.40	4.40	4.50	4.60	5.50	.....	4.30	4.10	4.50	.....	4.40	4.30
10	4.40	4.40	4.50	4.70	5.60	5.90	4.30	4.10	4.50	.....	4.40	4.30
11	4.40	4.40	4.50	4.70	5.60	5.90	4.30	4.10	4.60	.....	4.40	4.30
12	4.40	4.40	4.50	4.80	5.80	5.80	4.30	4.10	4.60	.....	4.40	4.30
13	4.40	4.40	4.50	4.90	5.90	5.60	4.30	4.10	4.50	.....	4.40	4.40
14	4.40	4.40	4.50	4.90	6.20	5.60	4.20	4.10	4.50	.....	4.40	4.40
15	4.40	4.40	4.60	4.80	6.40	5.30	4.30	4.10	4.50	.....	4.40	4.40
16	4.40	4.40	4.60	4.80	6.40	5.30	4.20	4.10	.....	.....	4.40	4.40
17	4.40	4.40	4.60	4.70	6.40	5.30	4.20	4.10	.....	.....	4.40	4.40
18	4.40	4.40	4.60	4.70	6.20	4.90	4.20	.....	.....	.....	4.40	4.40
19	4.40	4.40	4.60	4.70	6.10	4.90	4.20	.....	.....	.....	4.40	4.40
20	4.40	4.40	4.60	4.70	6.20	4.80	4.20	.....	.....	.....	4.40	4.40
21	4.40	4.40	4.60	4.80	6.10	4.80	4.20	.....	.....	.....	4.40	4.50
22	4.40	4.40	4.60	4.90	6.10	4.60	4.10	4.10	.....	.....	4.40	4.50
23	4.40	4.40	4.60	5.00	6.00	4.50	4.10	.....	.....	.....	4.30	4.50
24	4.40	4.50	4.60	5.00	6.00	4.60	4.10	.....	.....	.....	4.30	4.40
25	4.40	4.50	4.60	5.10	6.10	4.60	4.10	.....	.....	4.40	4.30	4.20
26	4.40	4.50	4.60	5.30	6.20	4.50	4.10	4.10	.....	4.40	4.30	4.20
27	4.40	4.50	4.60	5.40	6.20	4.50	4.10	4.20	.....	4.50	4.30	4.10
28	4.40	4.50	4.70	5.40	6.30	4.50	4.10	4.30	.....	4.50	4.30	4.10
29	4.40	.....	4.80	5.40	6.40	4.50	4.10	4.20	.....	4.40	4.30	4.20
30	4.40	.....	4.80	5.30	6.40	4.40	4.10	4.20	.....	4.40	4.30	4.20
31	4.40	.....	4.70	.....	6.40	.....	4.10	4.10	.....	4.40	.....	4.20

LEAMINGTON STATION, ON SEVIER RIVER, UTAH.

Measurements of the Sevier River were begun on August 23, 1889, by Mr. T. M. Bannon, near the settlement of Leamington, on the Union Pacific Railroad. This place is in the gorge below the broad valley

in which Richfield and other towns are located, and above the plain whose lowest part is occupied by Sevier Lake. The quantities of water passing this point represent the drainage and excess from irrigated lands farther upstream, and show the amount available for use in developing the fertile lands above Sevier Lake. The gage was located back of the house of C. Overson, 1 mile from the Leamington depot. Observations of river height were continued from August 23, 1889, to December 31, 1893. The rating table given below was constructed from the gagings made during 1890 and 1891, and has not been verified for later dates.

Rating table of Sevier River at Leamington, Utah.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
	Sec. feet.		*Sec. feet.*		*Sec. feet.*		*Sec. feet.*		*Sec. feet.*
2.00	40	3.20	321	4.40	813	5.60	1,304	6.80	1,796
2.10	48	3.30	362	4.50	854	5.70	1,345	6.90	1,837
2.20	60	3.40	403	4.60	895	5.80	1,386	7.00	1,878
2.30	80	3.50	444	4.70	935	5.90	1,427	7.10	1,919
2.40	100	3.60	485	4.80	976	6.00	1,468	7.20	1,960
2.50	120	3.70	526	4.90	1,017	6.10	1,509	7.30	2,001
2.60	140	3.80	567	5.00	1,058	6.20	1,550	7.40	2,042
2.70	160	3.90	608	5.10	1,099	6.30	1,591	7.50	2,083
2.80	185	4.00	649	5.20	1,140	6.40	1,632	7.60	2,124
2.90	210	4.10	690	5.30	1,181	6.50	1,673	7.70	2,165
3.00	245	4.20	731	5.40	1,222	6.60	1,714	7.80	2,206
3.10	280	4.30	772	5.50	1,263	6.70	1,755	7.90	2,247
								8.00	2,288

Daily gage height of Sevier River at Leamington, Utah, for 1893.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1.....	4.80	5.60	3.90	4.60	3.10	4.80	2.40	2.00	3.30	2.00	2.40	2.40
2.....	4.80	4.00	3.90	4.30	3.00	4.70	2.40	1.90	3.40	2.00	2.40	2.40
3.....	4.80	4.00	4.00	4.20	3.00	4.70	2.40	1.90	3.40	2.00	2.40	2.30
4.....	4.80	4.00	4.00	4.10	3.20	4.50	2.40	2.00	3.40	2.00	2.30	2.30
5.....	4.90	3.90	3.80	4.10	3.30	4.50	2.40	2.00	3.40	2.00	2.30	2.30
6.....	4.90	3.90	3.60	4.10	3.40	4.30	2.40	1.90	3.40	1.90	2.30	2.30
7.....	4.90	3.80	3.40	4.10	3.50	4.10	2.30	2.00	3.40	1.90	2.40	2.30
8.....	4.80	3.80	3.20	4.10	3.70	3.90	2.30	2.00	3.30	1.90	2.40	2.30
9.....	4.70	3.90	3.00	4.00	4.00	3.90	2.30	2.20	3.30	1.90	2.40	2.30
10.....	4.70	3.90	3.00	4.00	4.00	3.90	2.30	2.20	3.40	1.90	2.40	2.30
11.....	4.70	3.90	3.00	4.00	4.00	3.80	2.30	3.60	3.40	2.00	2.30	2.30
12.....	4.40	4.00	3.00	4.00	4.20	3.80	2.30	3.00	3.40	2.00	2.30	2.40
13.....	4.40	4.00	3.00	4.10	4.20	3.70	2.30	3.00	3.40	2.00	2.30	2.40
14.....	4.40	4.00	3.00	4.10	4.30	3.70	2.30	3.10	3.40	2.00	2.30	2.40
15.....	4.40	3.90	3.00	4.10	4.60	3.50	2.30	3.20	3.40	2.00	2.30	2.30
16.....	4.30	3.90	3.00	4.10	4.60	3.40	2.10	3.20	3.40	2.20	2.30	3.30
17.....	4.30	3.90	3.00	4.00	4.70	3.40	2.10	3.30	3.10	2.30	2.30	2.30
18.....	4.30	3.90	3.00	4.00	4.80	3.40	2.10	3.40	3.00	2.30	2.30	2.30
19.....	4.20	3.80	3.40	4.00	5.90	3.30	2.10	3.40	2.90	2.30	2.30	2.40
20.....	4.00	3.80	3.80	4.00	5.00	3.20	2.00	3.40	2.90	2.30	2.30	2.50
21.....	3.90	3.80	4.60	4.10	5.00	3.20	2.00	3.50	2.70	2.30	2.20	2.50
22.....	3.90	3.90	4.80	4.10	5.00	3.20	2.00	3.60	2.70	2.20	2.20	2.50
23.....	3.80	3.80	5.00	4.10	5.00	3.20	2.10	3.70	2.70	2.20	2.20	2.50
24.....	3.90	3.90	4.90	4.10	5.00	3.20	2.10	3.80	2.40	2.20	2.20	2.60
25.....	3.90	3.80	4.80	4.00	5.00	2.50	2.10	3.70	2.50	2.20	2.20	2.60
26.....	3.80	3.80	4.70	3.90	4.90	2.50	4.90	3.60	2.10	2.20	2.30	2.60
27.....	3.70	3.90	4.80	3.60	4.80	2.50	5.60	3.50	2.00	2.20	2.30	2.60
28.....	3.80	3.90	4.90	3.40	4.80	2.50	3.50	3.40	2.00	2.20	2.40	2.60
29.....	3.90	.....	4.90	3.10	4.80	2.50	3.00	3.20	2.00	2.30	2.40	2.60
30.....	4.60	.....	4.80	3.10	4.80	2.50	2.00	3.10	2.00	2.30	2.40	2.60
31.....	5.60	.....	4.70	.....	4.80	.....	2.00	3.20	.....	2.40	.....	2.60

COLUMBIA BASIN, IN IDAHO, OREGON, AND WASHINGTON.

This great drainage basin includes, with its large tributary, the Snake, an area of 191,813 square miles, of which 108,680 square miles are tributary to Snake River, 59,040 square miles in Montana, Idaho, and Washington to the Columbia, and 24,093 square miles to the Columbia from the State of Oregon. It is obviously impossible to attack all of the problems of water supply in this great basin, comprising many thousand square miles of rich agricultural land, though arid, and innumerable localities favorable for the development of water power. A beginning, however, has been made, and stations were maintained for a longer or shorter time during 1893 and 1894 at Chase's ranch on the Teton; at Idaho Falls, Boise, Payette, and Weiser, Idaho; also at Nyssa, Vale, and Pendleton, Oreg., and at North Yakima, Yakima, Toppenish, and Satas, Wash.

CHASE STATION, ON TETON RIVER.

The point at which measurements of Teton River have been made is at Chase's ranch, near the mouth of the river canyon, about 3 miles from the town of Wilford. The nearest railroad station is Market Lake, on the Utah and Northern Railroad, 40 miles distant. The point at which measurements are made is about one-half mile above the highest canal, and is above all irrigating ditches. The station is equipped with a half-inch steel cable, having a clear stretch of 160 feet, and which is about 12 feet above low water. The tag wire marking the section is 15 feet below the cable. The gage is constructed of a piece of 2 by 4 inch timber, 18 feet long. It is inclined at an angle of about 25° to the horizon, and the top of the graduation is about 2 feet above the high-water marks on the banks. It is securely fastened by braces on each side. The zero of the gage is referred to a bench mark on a live stump about 40 feet north of the gage. This bench mark is 2.20 feet above the 5-foot mark on the gage. The station was established by Mr. L. D. Hopson, and readings were begun on April 4, 1890. Observations were finally discontinued on October 11, 1893, owing to the expense of reaching the point and the necessity of verifying the rating table.

Rating table of Teton River at Chase's ranch, Idaho.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
	Sec. feet.		*Sec. feet.*		*Sec. feet.*		*Sec. feet.*
1.40	425	2.80	1,070	4.20	2,360	5.60	4,065
1.50	450	2.90	1,140	4.30	2,475	5.70	4,190
1.60	475	3.00	1,215	4.40	2,590	5.80	4,315
1.70	510	3.10	1,295	4.50	2,710	5.90	4,445
1.80	545	3.20	1,375	4.60	2,830	6.00	4,575
1.90	585	3.30	1,455	4.70	2,950	6.10	4,710
2.00	625	3.40	1,545	4.80	3,070	6.20	4,850
2.10	670	3.50	1,635	4.90	3,190	6.30	4,990
2.20	720	3.60	1,725	5.00	3,315	6.40	5,130
2.30	770	3.70	1,825	5.10	3,440	6.50	5,270
2.40	820	3.80	1,925	5.20	3,565	6.60	5,410
2.50	875	3.90	2,025	5.30	3,690	6.70	5,550
2.60	935	4.00	2,135	5.40	3,815	6.80	5,690
2.70	1,000	4.10	2,245	5.50	3,940	6.90	5,830

Daily gage height of Teton River at Chase's ranch, Idaho, for 1893.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	.....	1.40	2.50	4.00	4.70	2.90	1.90	1.80
2	.....	1.50	2.60	4.30	4.60	2.90	1.90	1.80
3	.....	1.50	2.70	3.90	4.50	2.90	1.80	1.80
4	.....	1.50	2.80	3.60	4.40	2.80	1.80	1.80
5	.....	1.60	2.90	3.90	4.30	2.80	1.80	1.80
6	.....	1.70	3.00	4.20	4.20	2.70	1.80	1.80
7	.....	1.80	3.10	4.80	4.10	2.70	1.80	1.80
8	.....	1.80	3.20	5.00	4.00	2.60	2.00	1.80
9	.....	1.90	3.30	5.40	3.80	2.60	2.00	1.80
10	.....	1.80	3.40	5.90	3.70	2.50	1.90	1.80
11	.....	1.70	3.50	6.20	3.70	2.40	1.80	1.80
12	.....	1.90	3.60	6.60	3.60	2.40	1.80	.....
13	.....	2.00	3.70	6.90	3.60	2.30	1.80	.....
14	.....	2.00	3.80	6.80	3.60	2.30	1.80	.....
15	.....	2.10	3.90	6.70	3.50	2.30	1.80	.....
16	.....	2.20	4.00	6.50	3.50	2.20	1.80	.....
17	.....	2.20	4.20	6.40	3.50	2.20	1.70	.....
18	.....	2.30	4.40	6.20	3.50	2.20	1.70	.....
19	1.40	2.20	4.10	6.10	3.40	2.10	1.70	.....
20	1.40	2.10	3.50	6.00	3.30	2.10	1.70	.....
21	1.40	2.20	3.20	5.90	3.30	2.10	1.70	.....
22	1.40	2.20	3.10	5.70	3.20	2.10	1.70	.....
23	1.40	2.20	2.80	5.60	3.20	2.10	1.70	.....
24	1.40	2.30	2.50	5.40	3.20	2.00	1.70	.....
25	1.40	2.20	2.10	5.30	3.10	2.00	1.60	.....
26	1.40	2.10	2.20	5.20	3.10	2.00	1.60	.....
27	1.40	2.00	2.30	5.10	3.10	2.00	1.60	.....
28	1.40	2.20	2.50	5.00	3.00	1.90	1.60	.....
29	1.40	2.30	2.60	4.90	3.00	1.90	1.60	.....
30	1.40	2.40	3.00	4.80	3.00	1.90	1.60	.....
31	1.40	.....	3.50	.....	3.00	1.90	.....	.....

IDAHO FALLS STATION, ON SNAKE RIVER.

This station is situated about 2 miles below the town of Idaho Falls, formerly known as "Eagle Rock." At the town the river flows through a narrow gorge in the lava, forming whirlpools, and having a velocity so great that current-meter measurements can not be made. Below the railroad bridge, however, it begins to widen, and finally spreads over a broad, gravelly channel, being confined by high banks on both sides. Accurate measurements can be made in low water, and fair results can probably be obtained during flood by means of suitable apparatus. The gage is on the right-hand side of the left bank of the stream, and is a short distance below the house of Mr. E. J. Wilson. It has an inclination of about 30°, and the graduation extends up to 12.5 feet. It is made of 2 by 4 inch scantling, nailed to stakes firmly driven into the river bed and bank. The bench mark is a spike driven into a large cedar tree, formerly used as one of the supports of the cable. The 2.3 mark of the gage is 9.60 feet below this bench mark.

This station was established by Mr. L. D. Hopson and readings begun on July 1, 1889. It was inspected by Mr. Arthur P. Davis on October 3, 1894, but measurements of discharge could not be made until a cable was placed in position. A measurement was made at the wagon bridge at Blackfoot, but the conditions there are not favorable for accurate results. The main current is diagonal to the direction of the channel, and there are numerous small eddies and points where the water is apparently still. Four large piers obstruct the channel, thus complicating the measurements. The maximum velocity was found to be about 6 feet per second, and the depth, 12 feet. The total discharge at this point on November 1, 1894, was estimated to be 8,040 second-feet. The following rating table was constructed from measurements made during preceding years, but has not been verified by recent measurements.

Rating table of Snake River at Idaho Falls, Idaho.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
	Sec. feet.		*Sec. feet.*		*Sec. feet.*		*Sec. feet.*		*Sec. feet.*
1.00	1,500	3.00	5,100	5.00	11,450	7.00	21,500	9.00	37,900
1.10	1,600	3.10	5,375	5.10	11,875	7.10	22,150	9.10	38,900
1.20	1,700	3.20	5,650	5.20	12,300	7.20	22,800	9.20	40,000
1.30	1,825	3.30	5,950	5.30	12,750	7.30	23,500	9.30	41,100
1.40	1,950	3.40	6,250	5.40	13,200	7.40	24,200	9.40	42,200
1.50	2,100	3.50	6,550	5.50	13,650	7.50	24,925	9.50	43,300
1.60	2,250	3.60	6,850	5.60	14,100	7.60	25,650	9.60	44,400
1.70	2,400	3.70	7,150	5.70	14,550	7.70	26,425	9.70	45,500
1.80	2,550	3.80	7,450	5.80	15,000	7.80	27,200	9.80	46,600
1.90	2,725	3.90	7,750	5.90	15,450	7.90	28,000	9.90	47,700
2.00	2,900	4.00	8,050	6.00	15,900	8.00	28,800	10.00	48,800
2.10	3,100	4.10	8,350	6.10	16,400	8.10	29,675	10.10	49,900
2.20	3,300	4.20	8,650	6.20	16,900	8.20	30,550	10.20	51,000
2.30	3,500	4.30	8,975	6.30	17,450	8.30	31,425	10.30	52,100
2.40	3,700	4.40	9,300	6.40	18,000	8.40	32,300	10.40	53,200
2.50	3,900	4.50	9,650	6.50	18,575	8.50	33,225	10.50	54,300
2.60	4,100	4.60	10,000	6.60	19,150	8.60	34,150	10.60	55,400
2.70	4,350	4.70	10,350	6.70	19,725	8.70	35,075	10.70	56,500
2.80	4,600	4.80	10,700	6.80	20,300	8.80	36,000	10.80	57,600
2.90	4,850	4.90	11,075	6.90	20,900	8.90	36,950	10.90	58,700

Daily gage height of Snake River at Idaho Falls, Idaho, for 1893.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	2.60	6.10	7.60	3.70	2.30	2.30	2.30	2.30
2	.....	2.70	6.40	7.30	3.70	2.30	2.30	2.30	2.35
3	.....	2.70	6.80	7.10	3.50	2.30	2.30	2.30	2.40
4	.....	2.85	7.00	7.10	3.40	2.30	2.30	2.30	2.40
5	.....	2.90	6.80	7.10	3.40	2.30	2.30	2.30	2.40
6	.....	3.00	6.80	7.10	3.30	2.30	2.30	2.30	2.50
7	.....	3.05	7.00	7.00	3.20	2.30	2.30	2.30	2.50
8	.....	3.25	7.30	6.60	3.10	2.30	2.30	2.30	2.50
9	.....	3.60	7.60	6.30	3.00	2.30	2.30	2.30	2.50
10	.....	4.15	7.80	6.00	3.00	2.30	2.30	2.30	2.50
11	.....	4.45	8.30	6.00	2.90	2.30	2.30	2.30	2.40
12	.....	4.50	8.70	6.00	2.80	2.30	2.30	2.30	2.40
13	.....	4.65	9.30	6.00	2.80	2.30	2.30	2.30	2.40
14	.....	5.10	9.60	5.80	2.80	2.30	2.30	2.30	2.30
15	.....	5.60	9.50	5.60	2.80	2.30	2.30	2.30	2.30
16	.....	6.15	9.20	5.40	2.70	2.30	2.30	2.30	2.30
17	.....	6.80	8.90	5.30	2.70	2.30	2.30	2.30	2.30
18	.....	7.70	9.00	5.10	2.60	2.30	2.30	2.30	2.30
19	.....	8.15	9.30	5.00	2.60	2.30	2.30	2.30	2.40
20	.....	7.80	9.50	4.90	2.60	2.30	2.30	2.30	2.40
21	.....	7.15	9.50	4.80	2.60	2.30	2.30	2.30	2.40
22	.....	6.60	9.30	4.60	2.60	2.30	2.30	2.30	2.40
23	2.50	6.30	8.90	4.60	2.60	2.30	2.30	2.30	2.40
24	2.50	6.30	8.70	4.50	2.50	2.30	2.30	2.30	.....
25	2.50	6.30	8.40	4.50	2.50	2.30	2.30	2.30	.....
26	2.60	6.00	8.10	4.40	2.50	2.30	2.30	2.30	.....
27	2.60	5.80	7.90	4.30	2.40	2.30	2.30	2.30	.....
28	2.60	5.60	7.80	4.20	2.40	2.30	2.30	2.30	.....
29	2.60	5.50	7.80	4.00	2.40	2.30	2.30	2.30	.....
30	2.60	5.85	7.70	3.90	2.40	2.30	2.30	2.30	.....
31	.....	6.00	.....	3.80	2.30	.....	2.30	.....	.....

Daily gage height of Snake River at Idaho Falls, Idaho, for 1894.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Nov.	Dec.
1	2.70	5.10	12.00	9.00	5.20	3.60	3.20	2.70
2	2.70	5.30	12.00	8.90	5.00	3.60	3.20	2.70
3	2.70	5.20	(a)	8.90	4.90	3.60	3.20	2.60
4	2.70	5.10	.....	8.80	4.90	3.60	3.10	2.50
5	2.50	5.20	.....	8.70	4.90	3.60	3.10	2.50
6	2.50	5.30	.....	8.70	4.80	3.50	3.00	2.60
7	2.50	6.00	.....	8.70	4.70	3.50	3.00	2.70
8	2.50	6.70	.....	8.50	4.70	3.60	3.00	2.70
9	2.60	7.30	.....	8.50	4.60	3.70	3.00	2.50
10	2.70	7.70	11.60	8.50	4.60	3.60	2.95	2.50
11	2.70	7.80	11.40	8.50	4.50	3.60	2.90	2.50
12	2.80	7.90	11.20	8.40	4.40	3.60	2.90	2.50
13	2.90	8.20	10.70	8.30	4.30	3.50	2.90	2.50
14	2.90	8.90	10.40	8.10	4.30	3.50	2.90	2.50
15	2.90	9.40	10.00	7.90	4.20	3.40	2.90	2.50
16	3.00	9.50	9.60	7.60	4.20	3.40	2.80	2.40
17	3.10	9.70	9.50	7.50	4.10	3.40	2.90	2.40
18	3.10	9.30	9.50	7.40	4.10	3.40	2.80	2.40
19	3.20	9.10	9.60	7.20	4.00	3.40	2.80	2.40
20	3.20	9.40	9.60	7.10	4.00	3.40	2.80	2.50
21	3.30	9.90	9.70	6.90	4.00	3.30	2.80	2.50
22	3.30	10.20	9.50	6.80	3.90	3.30	2.80	2.50
23	3.50	10.30	9.50	6.60	3.90	3.30	2.75	2.40
24	4.10	10.40	9.50	6.40	3.80	3.30	2.70	2.40
25	4.50	10.60	9.50	6.20	3.80	3.30	2.70	2.40
26	4.90	10.70	9.40	6.00	3.70	3.30	2.80	2.40
27	5.00	10.90	9.30	5.90	3.60	3.30	2.80	2.40
28	5.10	11.20	9.20	5.70	3.60	3.30	2.80	2.30
29	5.00	11.40	9.10	5.40	3.50	3.30	2.80	2.30
30	4.90	11.50	9.00	5.30	3.50	.....	2.80	.....
31	.....	12.00	.....	5.20	3.50	.....	.....	.....

a Under water June 3 to 9.

BOISE STATION, ON BOISE RIVER.

This station is located 8 miles from Boise, Idaho, in front of Mrs. McNell's house. It was established on December 15, 1894, by Messrs. Arthur P. Davis and V. C. Tompkins. The observer is Mr. B. Cronin, Boise, Idaho. The station is distant from the observer's house about 150 yards. The gage is in two sections; the lower part is of 2 by 6 inch plank, inclined, and marked from 1 foot to 7.5 feet; the upper part is a 4 by 4 inch timber, placed vertically, and marked from 7.5 to 12 feet, both portions painted white. The channel is gravelly. The bench mark is a bridge spike driven into a cottonwood tree 20 feet from gage and 20 feet from river. It is 3.4 feet above 8-foot mark on the gage. Measurements are made from a cable just below the gage.

PAYETTE STATION, ON PAYETTE RIVER.

This station is located at the highway bridge, one-half mile south of Payette, Idaho. It was established on December 7, 1894, by Messrs. Arthur P. Davis and V. C. Tompkins. The observer is Mr. Murray Mott, the town marshal at Payette. The station is distant from the observer's house about one-half mile. The gage is vertical, of pine plank, spiked to a wooden pier, graduated from 0 to 12.5 feet. It is easily read from the bridge. The character of the channel is sandy and shifting. The point 12.5 on the gage is level with the top of the pier, on which is the mark "B. M." Measurements of discharge were made from the same bridge. On the date above given the height was 1.3 feet and the discharge was 1,603 second-feet.

WEISER STATION, ON WEISER RIVER.

This station is located about 10 miles from Weiser, Idaho, just above the ford, on the right bank of the Weiser River. It was established on December 6, 1894, by Mr. Arthur P. Davis. The observer is Mr. J. W. Lane, whose house is about one-fourth of a mile distant from the station. The gage is partly inclined and partly vertical. The inclined portion is graduated from 0.8 to 5.8 feet; the vertical portion, from 6 feet to 10 feet. The marking is with nails and tacks. Bench Mark No. 1 is the highest point of a solid rock 40 feet southwest of the south anchorage or dead man, and is 14.54 feet above the 5-foot mark on the gage. Bench Mark No. 2 is the highest point of a solid rock 60 feet southwest of the dead man, and is 20.16 above the 5-foot mark on the gage. The channel is gravelly. The measurement on December 6, 1894, when the water was at 0.9 foot, gave a discharge of 277 second-feet.

NYSSA STATION, ON OWYHEE RIVER.

This station is located about 20 feet above the new county bridge across the Owyhee River, 1½ miles from Owyhee, Oreg., and one-half mile from the house of the observer, Mr. D. T. Rigsby, near which the former station was located. It was established on December 8, 1894,

by Messrs. Arthur P. Davis and V. C. Tompkins. The gage is inclined, of 5 by 5 inch timber, marked from 1 foot to 13 feet. The distance between footmarks on the lower half is 2.77 feet. The bench mark consists of a spike driven in a large stump about 20 feet from the left bank of the river and 300 feet below the gage. It is the same bench mark formerly used, and is 4.35 feet above the 11-foot mark. The channel is sandy and shifting. The measurement on December 8, 1894, made from the bridge, showed for a height of 1.4 feet a discharge of 307 second-feet. The following tables give the ratings for the old station and the readings of river height for 1893, the applicability of the rating table being somewhat doubtful.

Rating table of Owyhee River at Rigsby's, Oregon.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
	Sec. feet.		*Sec. feet.*		*Sec. feet.*		*Sec. feet.*
1.00	130	2.80	1,200	4.60	3,910	6.40	7,800
1.10	150	2.90	1,320	4.70	4,080	6.50	8,120
1.20	170	3.00	1,440	4.80	4,250	6.60	8,450
1.30	200	3.10	1,570	4.90	4,420	6.70	8,800
1.40	240	3.20	1,700	5.00	4,600	6.80	9,200
1.50	280	3.30	1,850	5.10	4,780	6.90	9,600
1.60	320	3.40	2,000	5.20	4,960	7.00	10,000
1.70	360	3.50	2,150	5.30	5,150	7.10	10,400
1.80	400	3.60	2,300	5.40	5,350	7.20	10,800
1.90	450	3.70	2,450	5.50	5,560	7.30	11,200
2.00	500	3.80	2,600	5.60	5,770	7.40	11,600
2.10	560	3.90	2,750	5.70	6,000	7.50	12,000
2.20	630	4.00	2,900	5.80	6,230	7.60	12,400
2.30	700	4.10	3,060	5.90	6,460	7.70	12,800
2.40	800	4.20	3,230	6.00	6,700	7.80	13,200
2.50	900	4.30	3,400	6.10	6,950	7.90	13,600
2.60	1,000	4.40	3,570	6.20	7,220		
2.70	1,100	4.50	3,740	6.30	7,500		

Daily gage height of Owyhee River at Rigsby's, Oregon, for 1893.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1.....	2.40	2.50	2.80	5.90	6.85	3.50	2.90	2.70	2.40	2.60	2.60	2.90
2.....	2.40	2.50	2.80	6.05	7.00	3.40	2.80	2.70	2.40	2.60	2.60	2.90
3.....	2.40	2.50	2.80	6.20	7.55	3.40	2.80	2.70	2.60	2.60	2.60	3.10
4.....	2.40	2.50	2.80	6.45	7.85	3.25	2.80	2.70	2.60	2.60	2.60	3.50
5.....	2.40	2.60	2.90	6.75	8.05	3.20	2.80	2.70	2.60	2.60	2.60	3.70
6.....	2.40	2.60	2.90	6.80	8.20	3.20	2.80	2.60	2.60	2.60	2.60	4.00
7.....	2.40	2.60	2.90	6.90	8.00	3.20	2.80	2.60	2.60	2.60	2.70	4.10
8.....	2.40	2.60	2.90	7.05	8.00	3.20	2.80	2.60	2.60	2.60	2.80	4.10
9.....	2.40	2.60	2.90	7.10	7.55	3.20	2.80	2.60	2.60	2.60	2.80	4.00
10.....	2.40	2.60	2.90	7.00	7.00	3.20	2.80	2.60	2.60	2.60	2.90	3.80
11.....	2.40	2.60	2.90	7.00	6.90	3.00	2.80	2.60	2.60	2.60	2.90	3.60
12.....	2.40	2.60	3.05	6.80	6.85	3.00	2.80	2.60	2.60	2.60	3.00	3.40
13.....	2.40	2.60	3.25	6.60	6.50	3.00	2.80	2.50	2.60	2.60	3.10	3.30
14.....	2.40	2.60	3.40	6.50	6.40	3.00	2.80	2.50	2.60	2.60	3.10	3.20
15.....	2.40	2.60	3.55	6.40	6 10	3.00	2.80	2.50	2.60	2.60	3.20	3.00
16.....	2.40	2.60	3.70	6.00	5.00	3.00	2.80	2.50	2.60	2.60	3.20	3.00
17.....	2.40	2.60	3.85	5.50	4.85	3.00	2.80	2.50	2.60	2.60	3.20	2.90
18.....	2.40	2.60	4.00	5.00	4.40	3.00	2.80	2.50	2.60	2.60	3.20	2.90
19.....	2.40	2.70	4.50	4.40	4.40	3.00	2.80	2.50	2.60	2.60	3.10	2.80
20.....	2.40	2.70	4.60	4.00	4.25	3.00	2.80	2.40	2.60	2.60	3.10	2.80
21.....	2.40	2.70	4.70	3.90	4.00	3.00	2.80	2.40	2.60	2.60	3.00	2.70
22.....	2.40	2.70	4.80	3.80	3.85	3.00	2.80	2.40	2.60	2.60	3.00	2.80
23.....	2.40	2.70	4.80	4.20	3.80	3.00	2.80	2.40	2.60	2.60	3.00	3.00
24.....	2.40	2.70	4.80	4.55	3.80	3.00	2.80	2.40	2.50	2.60	3.00	3.10
25.....	2.40	2.70	4.80	4.80	3.80	2.90	2.80	2.40	2.50	2.60	3.20	3.00
26.....	2.40	2.80	5.10	5.30	3.70	2.90	2.80	2.40	2.50	2.60	3.10	2.90
27.....	2.40	2.80	5.40	5.55	3.85	2.90	2.80	2.40	2.50	2.60	3.10	2.80
28.....	2.40	2.80	5.50	5.65	3.50	2.90	2 80	2.40	2.50	2.60	3.00	2.80
29.....	2.50	.....	5.50	5.90	3.50	2.90	2.80	2.40	2.50	2.60	3.00	2.80
30.....	2.50	.....	5.60	6.65	3.50	2.90	2.70	2.40	2.50	2.60	2.90	2.90
31.....	2.50	.....	5.80	.....	3.50	.....	2.70	2.40	.....	2.60	.....	2.90

VALE STATION, ON MALHEUR RIVER.

This station is located on the left bank of the Malheur River, about 150 feet below the junction with Bully Creek and 50 feet above the iron bridge now in construction. It was established by Messrs. Arthur P. Davis and V. C. Tompkins on December 10, 1894. The observer is Mr. E. R. Murray, postmaster, Vale, Oreg. The station is distant from the observer's house about one-fourth of a mile. The gage is inclined, and is in two parts. The lower part is graduated from 1.6 to 9.1 feet, the distance between the footmarks being 1.95 feet. The upper part is graduated from 9.1 to 11.7 feet, the distance between the footmarks being 3 feet. The channel is composed of earth and sand, and is shifting. The bench mark is on a flat rock, nearly buried, above the right bank of the river, 50 feet southeast of south abutment of new bridge, and is 1.32 feet above the 11-foot mark on the gage. In future, measurements are to be made from the bridge. On December 10, 1894, the height was 1.9 feet and discharge 128 second-feet.

PENDLETON STATION, ON UMATILLA RIVER.

A station was established at Pendleton, Oreg., in January, 1891, by Mr. A. L. Adams, chief engineer of the Umatilla Irrigation Company, of Oregon. The section selected was at the point of crossing of the Main street bridge, the gage rod being placed on the central pier of the bridge. A record of the height of the stream was kept at short intervals for a period of over two years, daily readings being made at times when there were decided changes in the height of the stream. When, however, owing to absence of precipitation or to lack of change in the weather affecting the snow in the mountains, the river did not rise or fall notably, no readings were taken, the condition of the stream being watched carefully and observations taken only when necessary.

During this period measurements of discharge by means of floats were made by Mr. Adams, from which a rating table was constructed and the record of gage-height readings utilized in preparing a table of monthly discharges. These as computed extend from February, 1891, to July, 1892.

Table of monthly discharges of Umatilla River at Pendleton, Oregon.

[Total drainage area, 640 square miles.]

Month.	Discharge.			
	Maximum.	Minimum.	Mean.	Total for month.
1891.	*Sec. feet.*	*Sec. feet.*	*Sec. feet.*	*Acre feet.*
January				
February	320	140	180	9,997
March	2,250	140	1,050	64,562
April	2,250	770	1,430	85,091
May	520	140	408	25,087
June	370	140	202	12,020
July	770	60	300	18,446
August	60	60	60	3,689
September	55	35	45	2,678
October	65	35	50	3,074
November	580	60	172	10,235
December	520	410	510	31,359
1892.				
January	830	470	587	36,093
February	2,030	630	1,120	62,202
March	2,800	1,000	1,753	107,788
April	3,870	1,000	1,706	101,514
May	3,250	920	2,090	128,509
June	920	125	455	27,074
July	125	45	74	4,550

On January 9, 1893, Mr. William P. Trowbridge, jr., inspected this station and made a measurement of the discharge at that time, and also made arrangements for the continued reading of the river gage. Owing, however, to uncertainty as to paying necessary expenses, the records were not continued for a time sufficiently long to be of value. Mr. Trowbridge states that the bridge over the stream affords an excellent opportunity for measurements by means of current meters, as the stream at this point is narrow and is confined between a high clay and gravel bank on the north side and an embankment or levee on the south side. The latter was constructed by the town of Pendleton to prevent inundations, which have occurred at times of flood. The section here is good, as the bottom of the river is covered with pebbles and gravel, and apparently is not liable to change. At a point about 60 feet from the south bank of the stream the bridge is supported by a tubular iron pier consisting of two cement-filled iron pipes of a diameter of about 30 inches. This pier offers an obstruction, but as the sidewalk of the bridge projects considerably upstream the meters can be used to advantage. A measurement made on January 14, 1893, gave a discharge of 239 second-feet for a gage height of 1.53. The area of section was 126 square feet, the maximum velocity 3.07 feet per second, and the mean velocity 1.90 feet per second.

At that time a report upon the Umatilla River, its tributaries, and the diversion of water for power and irrigation was made by Mr. Trowbridge. The following extracts from this unpublished report give the principal facts, the maps and illustrations being omitted:

Umatilla River heads in the Blue Mountains, in the northeastern part of the State of Oregon, and flows in a westerly direction into the Columbia River. The moun-

tains from which this stream draws its supply are from 4,000 to 7,000 feet in height, and are covered with a heavy growth of timber. The principal tributaries are Meacham Creek, which has its head a little to the south of the main stream and flows in a general northerly direction, emptying into the Umatilla at a point about 65 or 70 miles from its mouth; Wild Horse Creek, rising a little to the north of the main stream and flowing in a general westerly direction, emptying into the Umatilla near Pendleton; McKaye Creek, which rises still farther to the south of Meacham Creek, flows in a general northerly direction, and empties into the Umatilla 3 miles below Pendleton; Birch Creek, which runs parallel to McKaye Creek; and Butter Creek, which empties into the Umatilla at a point about 12 miles from its mouth. Of the above-named tributaries Meacham Creek is the largest. A considerable volume of water flows from this stream. Wild Horse Creek carries but little water at the present season (January, 1893), but is in volume about sufficient for the watering of stock. McKaye Creek is a stream of considerable importance. Its drainage area is estimated to be about 200 square miles in extent. At a point about 20 miles from its mouth the stream divides into the north and south forks. This whole stream is perennial in its flow, but at a point about 10 or 12 miles from its mouth it disappears in the sands and gravel of the bottom during a large portion of the year. During the high-water season there is a large body of water flowing its entire length, and above the point of disappearance there is a good stream flowing the year around. Birch Creek and Butter Creek are streams of the same character, though much smaller.

The total drainage area of the Umatilla River is estimated to be about 320 square miles. The available records show that the year 1891, excepting the month just following the irrigating season, had less rainfall than any year since 1874, which had but slightly less. During 1891 the total discharge from the watershed, as computed from the record of the gagings, was 302,000 acre-feet, being equivalent to about 18 inches of run-off from the efficient portion of the drainage area.

As is usually the case in most districts where irrigation is a necessity and the water supply is far less than the demand, the appropriations of the waters of the Umatilla River filed by the various companies and individuals far exceed the possible supply from the river.

The oldest water right on the Umatilla River is believed to be that of Mr. W. S. Byers, of Pendleton, dating back to the year 1870, renewed in 1874, or rather filed upon again. In the year 1883, fearful that the establishment of the line of the Umatilla Indian Reservation might affect his former claims, Mr. Byers again filed, being assured that his diversion of water was outside of the established reservation line. He claims the amount required for the development of power sufficient to run his flouring mill in the town of Pendleton. This mill has a capacity of 500 barrels of flour daily.

Water is diverted from the Umatilla River about 1¼ miles above Byers's mill, and is brought through a natural channel of the river for a short distance; thence through a ditch to a point on the bluff opposite the mill, distant about 1,200 feet. The ditch is 10 feet wide on the bottom and 22 feet wide on top, with an average depth of 3 feet. From the terminus of the ditch line the water is carried through a wooden pipe of a diameter of 7 feet 2 inches, made of 5-inch staves 2.5 inches thick. From the head of the ditch, or rather from the point of diversion to the point where the water is applied for power, is a fall of 18 feet.

The discharge from the wooden pipe—that is, the total water power—can not be estimated, as the pipe is cross braced in the inside in such a manner that nothing can be known. The water is distributed to two turbine wheels of the Victor pattern. One is a 20-inch wheel of a calculated horsepower of 100; the other is a 30-inch wheel of 156 horsepower. The waste and overflow from the distributing box at the end of the ditch is carried off through the town in an open channel. The tail-water from the mill is carried through a stone aqueduct 8 feet high to the river, distant about 1,200 feet.

During the low-water stage of the Umatilla River there are times when the mill can not run its full capacity on account of the shortage of water. It is then customary to run one turbine, and let the water in the ditch back up and accumulate for a head; then the other wheel is put in operation. Each wheel has certain duties, and at these times each branch of the work of milling is taken up separately. During this period the mill utilizes all the water of the river. The period varies during different years, and usually commences July 1. This water right is considered very valuable and is not contested. The water could be utilized to good advantage to the town of Pendleton for power in connection with the lighting of the town by electricity.

THE UMATILLA IRRIGATION COMPANY OF OREGON.

On the north and west of the town of Pendleton, Oreg., between the Umatilla and Columbia rivers, is an immense body of agricultural land, which has been settled upon for a number of years and cultivated. Wheat was the principal crop, and an excellent yield has been had; but, on account of the scarcity of rainfall, crops have failed in recent years, and most of the farms have been abandoned. This, of course, has been a great loss to the town of Pendleton. Efforts to reclaim the district were made in the year 1890, and as a result the Umatilla Irrigation Company was incorporated in that year.

The line of the proposed canal commenced in and ran through a portion of the Umatilla Indian Reservation, and the sanction of the United States Government was necessary. Steps were taken to get the desired authority, the outcome being the passage of a bill by Congress, in February, 1891, allowing the company to proceed with its work of reclamation, the consent of the Indians being required. This consent was obtained, and the Indians were compensated in the sum of $1,955. The land to be reclaimed lies on a plateau whose average elevation above sea level in 1,400 feet. The elevation of the river at Pendleton is about 1,070 feet, while the fall of the Umatilla River between Gibbon, at the mouth of Meacham Creek, and Pendleton averages about 32 feet per mile.

The lands slope from the mountains to the Columbia River, and are all capable of being irrigated. The actual amount of land to be irrigated, however, depends entirely upon the available supply of water. The company has contracted to supply 1,500 acres of good land with water for irrigation purposes at the rate of $3 per acre per annum for a period of thirty years, the amount of water to be delivered to be 1 acre-foot between March 1 and July 1. The contract provides for the delivery of water to the land free of cost at the expiration of the thirty-year period, the payment of the annual pro rata expense of the cost of maintenance being the only provision. The contracts are a mortgage upon the land and a first lien upon the crops irrigated.

The company proposes to divert water from the Umatilla River at a point about 18 miles above Pendleton by means of a crib diverting dam extending across the stream. The location of the diversion is on the NW. $\frac{1}{4}$ sec. 3, T. 2 N., R. 35 E., Willamette meridian. The water is to be carried down the side hill of the canyon in a box flume 6 by 8 feet, with a grade of 1 foot in 500 feet. In all, there are to be 4.5 miles of this fluming. From the end of this flume the water is carried through an ordinary side-hill canal. At a point about 9$\frac{3}{4}$ miles from its head the water is brought to the hilltop and leaves the canyon. From this point it is carried in a general northerly direction toward the town of Adams, on Wild Horse Creek. The canal crosses Wild Horse Creek by means of a flume 40 feet high, and from thence is carried in a westerly direction, following the general contour of the country until it reaches a point opposite the town of Pendleton and distant about 2 miles from it. Here the location survey ends. From the head to this point the canal is 49 miles in length. The canal is designed for a capacity of 560 second-feet, and is to be 28 feet wide on the bottom; maximum depth, 7.5 feet; side slopes, 1 to 1; uniform grade

of 1 foot in 5,000 in earth, and 1 foot in 12,500 in loose rock. From the end of the location work it is proposed to run two branch lines covering the land in question. The estimated cost of the system when finished is $400,000.

UMATILLA IMPROVEMENT COMPANY.

This company was formed for the purpose of reclaiming certain lands lying between the Umatilla and Columbia rivers. The company constructed 1 or 2 miles of their canal, diverting water at a point just below Echo, on the Umatilla River. For reasons not stated, this project was abandoned, and the company lost its rights, these being acquired by the Columbia Valley Land and Irrigation Company.

COLUMBIA VALLEY LAND IRRIGATION COMPANY.

This company was incorporated for the purpose of reclaiming certain lands lying in the same position as the lands proposed to be irrigated by the Umatilla Improvement Company. They further proposed to irrigate a large tract of land lying south of the Columbia River, known as prairie land. The river at this point makes a bend to the south, and the force of the current is directed against the bank where the diversion takes place. No diverting dam is necessary, it being assumed that it is possible to drain the river during the low stages by opening the gates to their fullest extent.

The head gate of this canal is of cement and is furnished with fall brakes for the gates. There are six of these gates, each being 3 feet in width. The front of the gate is protected by rods running out in a slanting position, the rods preventing the accumulation of débris against the gates.

From the point of diversion to Butter Creek, a distance of 6 miles, following the bluff line, a canal is in operation whose dimensions are as follows: Bottom width, 28 feet; top width, 48 feet; maximum depth, 5 feet; grade, 1.52 feet per mile. In running this line the old works of the Umatilla Improvement Company were disregarded entirely. The capacity of the canal is 500 second-feet. The company claims 8,000 miner's inches under 6-inch pressure.

This canal, which is finished and in operation as far as Butter Creek, covers completely a fine tract of land between the bluff and the Umatilla River and Butter Creek. This land has a gentle slope toward the river, and by reason of its slope is finely adapted for the distribution of water. The land in question is known as the Umatilla Meadows, and has an area of 15,000 acres. This is all good, irrigable land. The soil is well adapted to the raising of crops of all descriptions. Although water has been running in the canal for a considerable time, there has been but little used for irrigation except in one or two instances. The coming season, however, a large body of land will be reclaimed.

There is a large tract of land lying west of Butter Creek and south of the Columbia River which the company proposes to reclaim by crossing Butter Creek by means of a flume 800 feet in length, continuing from the point where the present canal ends. It was thought advisable to cross the creek rather than follow up the creek and cross on grade. Butter Creek at certain periods contains considerable water, and this water can be turned into the main canal below the flume with less danger to the canal than if there were a grade crossing.

The canal line from Butter Creek follows the general contour of the country for a distance of 11 miles (location survey), and empties into a natural reservoir whose area is about 200 acres, capable of holding 71,000,000 cubic feet of water. This reservoir is 17 miles from the head of the canal. A slight outlay will be necessary to furnish suitable gates at the western end of the reservoir, as the main canal is carried on for 3 or 4 miles beyond this point. Actual surveys have shown the presence of six natural reservoirs lying in the tract under the ditch, and the slope of the land is such that ditches from the main canal can be constructed connecting it with these different reservoirs, thus enabling an immense amount of water to be

stored during the high-water stage of the Umatilla River and Butter Creek. The proposed canal is to be the same in description as the existing work, following the same gradient, etc.

THE BLUE MOUNTAIN IRRIGATION AND IMPROVEMENT COMPANY.

In the SW. ¼ sec. 1, T. 1 S., R. 33 E., Willamette meridian, the north and south forks of McKaye Creek join and flow in a westerly direction as the main stream of McKaye Creek. At a point about 7 miles below this junction the creek turns to the north and flows in a direction a little west of north, and empties into the Umatilla River 3 miles below Pendleton. From the high bend of the creek to the Umatilla River McKaye Creek runs about parallel to the course of Birch Creek. These two streams are separated from each other by a narrow ridge or bench containing about 12,000 acres of irrigable land. To the east of McKaye Creek, below the bend of the creek, and lying between McKaye Creek and the line of the diminished reserve of the Umatilla Reservation, is another body of fine irrigable land, containing in all about 18,000 acres. To the east of this body of land lies the Umatilla Reservation, containing many thousands of acres of fine land, which is at the present time cultivated by the Indians in wheat and other cereals.

McKaye Creek, from the junction, runs through a narrow valley, almost a canyon, with hills on each side. In its course from the junction of the north and south forks there is a fall of about 47 feet. This part of the stream is perennial in its flow, and carries a considerable amount of water.

The Blue Mountain Irrigation and Improvement Company propose to utilize the waters of McKaye Creek for the purpose of irrigating the lands described above. They have secured by act of Congress the right to divert the waters of this stream which run upon the diminished Umatilla Reserve, which act also gives them the right of way across a certain part of the reservation. Their project is to impound, by means of a dam and reservoir, the flood waters of this stream and conduct them through a canal and a branch canal upon the lands in question.

By constructing a dam across the main stream just below the forks it is possible to back the waters of the stream up for a considerable distance. A dam 60 feet high, with a height of 54 feet for the wasteweir, would back the water for a distance of 1½ miles up the forks. The proposed dam site is a natural one. On one side (the south) a perpendicular ledge of rock juts out into the water. On the north side there is a more gradual slope away from the river. It is proposed to make the wasteweir on top of this ledge, and to tunnel through it below for the outlet of the water to the canal. The capacity of the reservoir is estimated to be 1,700,000,000 gallons.

It is proposed to carry the water from this reservoir onto the lands to be irrigated by means of a canal of the following dimensions: For the first 7 miles the canal is to be 10 feet wide on the bottom, 18 feet on top, with average depth of 3 feet 6 inches, and the excessively large grade of 5 feet to the mile. The canal, after leaving the reservoir, winds its way down toward the bend of the stream below. The water is then carried up onto the narrow bench between Birch Creek and McKaye Creek, where the line follows down the crest of the ridge, and is to be utilized in covering the land between the two creeks. At a point 7 miles below the dam site it is proposed to cross McKaye Creek by means of an inverted syphon 3,200 feet in length, with a fall of 20 feet in that distance, and to run a branch line of the canal down on the north and east side of McKaye Creek, covering within the diminished reserve between the reserve line and McKaye Creek about 18,000 acres.

NORTH YAKIMA STATION, ON NACHES RIVER.

This station was established August 14, 1893, by Mr. F. H. Newell, at a point a few hundred yards above the mouth of the Naches River, near the bridge of the Northern Pacific Railroad. The vertical gage

was nailed to the crib work on the right-hand side of the river, above the railroad bridge, and can be read easily from the track. The 12-foot mark is 9.97 feet below the top of the rail on the bridge, the gage being about 60 feet easterly from the rail. The top of the iron pier, on the southeast end of the county bridge, is 5.87 feet above this 12-foot mark. Measurements were made from the county bridge. The locality is, however, not favorable for the purpose, as the water is very swift, and is broken by the piers of the bridge. The discharge on August 14, 1893, was ascertained to be 1,193 second-feet, the reading on the gage being 1 foot. The station was inspected by Mr. Arthur P. Davis on November 21, 1894. At this time he made measurements of discharge at Nelson's bridge, about 4 miles above. The measured discharge was 1,196 second-feet and the maximum velocity 4.58 feet per second. This locality is not considered good for measurements at high water.

Daily gage height of Naches River above North Yakima, Washington, for 1894.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	3.60	3.50	3.10	.....	4.80	7.30	.....	3.80	2.20
2	3.60	3.50	3.00	4.10	4.60	7.30	5.20	3.70	.....
3	3.60	3.50	2.90	4.40	4.60	.....	5.30	3.60	2.40
4	3.60	.....	.....	4.20	4.40	7.90	5.50	3.60	2.40
5	3.60	3.40	2.90	4.30	4.40	6.60	5.60	.....	2.30
6	3.60	3.40	2.90	3.90	4.40	6.40	5.70	3.40	2.30
7	.....	3.40	2.90	4.80	4.40	6.40	5.80	3.20	2.20
8	3.20	3.30	2.90	.....	4.40	6.30	.....	3.10	2.20
9	3.20	3.30	2.80	4.60	4.40	6.20	5.20	2.90	.....
10	3.60	3.30	2.80	4.70	4.40	.....	5.20	2.80	.....
11	3.50	.....	.....	5.30	4.40	5.30	5.10	2.80	.....
12	3.50	.....	2.80	5.30	4.40	5.20	5.10	.....	.....
13	4.40	.....	2.80	5.10	.....	5.10	4.80	2.90	.....
14	.....	.....	2.80	5.10	4.60	5.10	4.80	2.80	.....
15	6.60	.....	2.80	.....	4.60	5.20	.....	2.80	.....
16	5.60	.....	2.80	4.70	4.60	5.70	4.90	2.80	.....
17	5.20	.....	2.90	4.40	4.30	.....	4.90	2.70	.....
18	4.80	.....	.....	4.40	4.40	5.40	4.80	2.70	.....
19	4.80	2.90	2.90	4.40	4.80	5.60	4.80	.....	.....
20	4.80	2.90	2.80	4.90	.....	5.90	4.60	2.70	.....
21	.....	2.90	2.80	5.70	6.10	5.80	4.60	2.70	.....
22	4.20	2.90	2.80	.....	6.10	5.80	.....	2.60	.....
23	4.20	2.90	2.80	5.80	6.40	5.70	4.60	2.60	.....
24	4.20	2.90	3.10	5.90	7.20	.....	4.60	2.60	.....
25	4.10	.....	.....	5.90	7.70	5.40	4.50	2.60	.....
26	4.10	2.90	3.40	6.70	7.90	5.40	4.30	.....	.....
27	4.10	2.90	3.70	6.80	.....	5.30	4.20	2.40	.....
28	.....	3.10	4.10	6.10	7.40	5.30	3.90	2.40	.....
29	3.60	.....	5.40	.....	6.80	5.20	.....	2.30	.....
30	3.60	.....	4.10	5.10	6.60	5.20	3.90	2.30	.....
31	3.60	.....	4.90	.....	6.90	.....	3.80	2.20	.....

TOPPENISH STATION, ON TOPPENISH CREEK.

This station is located about 4 miles south of Toppenish station, at the crossing of the Northern Pacific Railroad. It was established on November 24, 1894, by Messrs. Samuel Storrow and Arthur P. Davis. The observer is the section foreman at Toppenish. The station is distant from the section house at Toppenish about 4 miles. The gage is of 2 by 6 inch scantling, painted white, graduated in black, and spiked to a pile and sleeper of the railroad bridge. Bench marks are to be established by Mr. Storrow. Measurements of discharge were made 80 yards above the bridge.

SATAS STATION, ON SATAS RIVER.

This station is located at the crossings of the Northern Pacific Railroad north of Satas station. There are two of these crossings at low water, three at high water, and seven at extreme floods. Gages were placed on the first three mentioned on November 24, 1894, by Messrs. Samuel Storrow and Arthur P. Davis. The observer is Mr. A. L. Williams, section foreman. These gages are distant from the observer's house 200 to 2,000 yards. They are marked with notches, nails, and black paint on a vertical pile. All can be read from the bridge. These gages are considered temporary. Mr. Storrow will place painted gages at all seven of the bridges and make connection with bench marks. Measurements of discharge were made on the two channels carrying water, at points a few hundred yards above the crossings.

SACRAMENTO BASIN, CALIFORNIA.

This basin includes the northern part of the Great Valley of California, and is drained by the largest rivers of the State. The problems of water supply and of water control are of the most varied character, on account of the peculiar topography and the character of the industries concerned. The rivers, rising in the high mountains, discharge enormous volumes of water, especially in times of flood, and descending rapidly from the mountains, they have great possibilities in the way of power. This power is utilized to a small extent for manufacturing, and in the past was largely employed in hydraulic mining. The débris resulting from these operations, swept down by floods, accumulated in the lower valleys, choked the waterways, or was carried over the low-lying farm lands. As a result, the aid of legislation was invoked, and further dumping of mining débris into the streams was prohibited, which resulted in the practical cessation of hydraulic mining. Many of the flumes and ditches erected for this purpose have of late years been utilized for irrigation, especially in fruit culture, and questions are arising continually concerning the amount of water flowing in the streams and its possible storage and utilization on a larger scale for irrigation works or power plants.

In the lower part of the valley of the Sacramento, and in the central portion, where the waters of the San Joaquin and its tributaries are received, other problems of the reclamation of swamp areas are brought prominently to the attention of the people of California. The State engineer and various commissions have collected data upon the subject, and during 1894 the commissioner of public works began a further examination, including surveys and measurements of volumes. The data thus obtained have not been published in full, those published relating mainly to flood volumes of the larger streams. At higher points a few measurements have been made by this Survey for the purpose of obtaining general information applicable to the smaller rivers. There are given herewith descriptions of stations at Red Bluff and Tehama, on the Sacramento River, and the heights of water

observed at these points by the Weather Bureau and the Central Pacific Railroad Company, respectively.

RED BLUFF STATION, ON SACRAMENTO RIVER.

This station is located at the northeast corner of the wagon bridge just east of the town. It was established and is read by the Weather Bureau. The station is distant one-fourth of a mile from the observer's office in town. The gage is a painted pine plank, placed vertically, fastened to a sycamore tree 20 or 30 feet from the bridge. The channel is sandy and shifting in character. Measurements of discharge were made from the same bridge, but the current is very swift and is badly broken by the piers, introducing a probable error in the measurements of, say, 20 per cent. About 9 miles above Red Bluff the river is in a broad, uniform channel, and has a slow velocity even at high stages, owing to the contraction in the canyon a short distance below. The ferryboat is large and the bow extends several feet beyond the water line, resulting in favorable conditions for discharge measurements. It was agreed between Mr. Lippincott and the county supervisors that if the Geological Survey would place a gage at this point, the ferryman, who is paid by the county, would be instructed to report regularly the height of water. Below the canyon, and above both Red Bluff and Tehama in times of high water, the river leaves its banks, and thus the total amount of water is not shown by the gages. At Tehama the river channel is broken by the bridge piers, but not as badly as at Red Bluff. No canals of importance are taken out above the ferry just mentioned.

Daily gage height of Sacramento River at Red Bluff, California, for 1893.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Dec.
1	9.30	4.40	4.30	12.50	6.40	4.90	2.20	1.60	1.30	6.40
2	8.70	4.00	4.20	13.00	6.60	4.80	2.20	1.50	1.30	7.50
3	6.30	6.60	4.40	12.60	6.80	4.80	2.10	1.50	1.30	5.10
4	5.80	12.50	4.40	11.20	6.90	4.80	2.00	1.50	1.30	4.00
5	6.30	10.40	6.00	12.00	6.80	4.60	2.00	1.50	1.20	3.30
6	5.90	7.00	5.10	21.40	6.50	4.80	2.00	1.50	1.20	2.80
7	5.20	5.80	4.80	16.80	6.50	4.70	2.00	1.50	1.20	2.60
8	4.80	7.50	11.20	15.00	7.00	4.60	2.00	1.40	1.20	2.40
9	4.60	7.00	9.60	11.90	7.10	4.60	2.00	1.40	1.20	2.30
10	4.50	6.70	7.20	11.90	7.90	4.40	2.00	1.40	1.40	2.20
11	4.40	6.60	18.60	10.40	7.60	4.40	2.00	1.40	1.60	2.10
12	4.40	10.80	11.00	9.80	7.60	4.40	2.00	1.40	1.80	2.00
13	3.90	10.20	8.40	9.00	7.90	4.20	2.00	1.40	1.60	1.80
14	4.00	7.20	7.40	8.30	7.90	4.10	2.00	1.40	1.00	2.80
15	5.20	6.80	7.00	9.80	7.60	3.80	2.00	1.40	1.00	3.70
16	7.10	6.40	8.30	7.60	7.70	3.50	2.00	1.40	1.00	3.40
17	5.70	6.20	9.30	7.40	8.50	3.30	2.00	1.30	1.00	3.00
18	5.00	5.50	13.20	6.90	8.00	3.20	1.80	1.30	1.00	2.50
19	4.60	5.30	13.20	6.60	7.10	3.00	1.80	1.30	1.00	2.00
20	4.30	5.00	11.50	6.50	6.70	3.00	1.80	1.30	1.00	1.80
21	4.00	4.80	16.50	6.50	6.20	2.90	1.80	1.30	1.00	2.50
22	3.80	4.80	13.00	7.00	6.20	2.80	1.80	1.30	1.00	5.60
23	3.50	4.70	11.00	8.50	6.00	2.60	1.80	1.30	1.00	5.00
24	3.50	4.60	10.80	8.20	6.00	2.60	1.80	1.30	.90	5.30
25	3.60	4.50	9.70	7.70	5.80	2.60	1.70	1.30	.90	5.40
26	4.80	4.40	9.20	7.30	5.60	2.50	1.70	1.30	.90	4.10
27	11.90	4.40	9.40	7.10	5.30	2.40	1.60	1.30	.80	3.40
28	5.50	4.40	9.50	7.20	5.10	2.40	1.60	1.30	.80	3.10
29	5.80	.....	9.90	6.80	5.00	2.40	1.60	1.30	.80	2.80
30	5.50	.....	10.50	6.70	4.90	2.30	1.60	1.30	.80	2.50
31	5.10	.....	13.00	.....	4.90	.....	1.60	1.30	.....	2.30

Daily gage height of Sacramento River at Red Bluff, California, for 1894.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.30	5.80	5.30	10.40	4.50	3.80	1.80	1.00	0.70	1.40	1.00	1.20
2	3.50	5.30	7.50	10.00	4.40	3.60	1.80	1.00	.70	1.00	1.00	1.00
3	3.00	4.90	6.50	9.40	4.20	3.70	1.70	1.00	.70	.70	.80	1.20
4	2.50	4.50	5.90	8.90	4.10	4.00	1.70	.90	.70	.70	.80	1.40
5	2.40	5.40	5.50	8.30	4.00	5.70	1.70	.90	.70	.70	.80	1.80
6	2.30	6.40	7.00	7.80	4.00	4.80	1.60	.90	.70	.70	1.00	5.20
7	2.20	5.40	6.00	7.40	4.50	4.30	1.60	.90	.70	.70	1.00	5.00
8	2.10	6.50	7.30	7.20	4.60	4.00	1.50	.80	.70	.70	1.00	9.50
9	2.00	5.90	7.00	7.00	4.50	3.80	1.50	.80	.70	.70	1.00	7.60
10	1.90	5.70	7.80	6.80	4.20	3.60	1.40	.80	.70	.70	1.00	6.40
11	1.90	5.50	7.00	7.00	4.10	3.50	1.40	.80	.70	.70	1.00	3.60
12	1.90	5.20	6.40	6.80	4.00	3.30	1.40	.80	.70	.70	.90	3.00
13	1.80	5.00	6.00	6.30	4.00	3.20	1.40	.80	.70	.70	.90	3.00
14	6.70	4.00	5.80	6.00	4.50	3.10	1.40	.80	.70	.70	.90	2.60
15	25.00	4.80	6.50	5.70	5.30	3.00	1.30	.80	.70	.70	.90	2.40
16	17.60	4.40	7.30	5.50	4.50	2.90	1.30	.80	.70	.70	.90	2.70
17	10.90	4.00	9.40	5.20	4.10	3.00	1.30	.70	.70	.70	.90	3.80
18	9.00	5.80	8.80	5.00	3.90	2.90	1.30	.70	.70	.80	.90	5.60
19	7.60	11.20	8.40	4.90	4.00	2.80	1.30	.70	.70	.90	.90	11.40
20	10.40	13.00	7.30	5.00	4.00	2.70	1.30	.70	.70	1.00	.90	11.30
21	9.20	8.80	6.80	5.00	3.90	2.60	1.30	.70	.70	1.10	.90	21.50
22	10.90	7.00	6.30	5.00	3.80	2.30	1.30	.70	.70	1.40	.90	15.30
23	10.20	6.00	6.00	5.10	3.70	2.30	1.30	.70	.60	1.90	.90	10.30
24	9.20	5.40	5.60	4.90	3.70	3.30	1.20	.70	.60	6.50	.90	6.70
25	8.10	5.00	5.20	4.80	3.60	2.20	1.10	.70	.60	3.40	.90	5.70
26	7.40	4.80	5.60	5.10	4.00	2.10	1.10	.70	.70	2.20	1.00	5.20
27	6.80	4.80	6.10	5.40	4.20	2.10	1.10	.70	.70	1.70	1.50	4.10
28	6.40	5.00	6.60	4.80	4.00	2.00	1.00	.70	.70	1.50	2.50	3.80
29	6.40	.....	7.20	4.60	3.70	2.00	1.00	.70	.70	1.30	2.40	4.80
30	7.20	.....	8.40	4.50	3.60	2.00	1.00	.70	1.20	1.20	2.00	6.60
31	6.40	.....	9.50	.....	3.60	.....	1.00	.70	.....	1.00	.....	7.40

Daily gage height of Sacramento River at Tehama Bridge, California, for 1893.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	19.00	15.00	14.00	20.50	16.50	15.67	13.67	12.83	12.50	12.50	12.50	16.50
2	18.00	15.00	14.00	20.50	16.50	15.67	13.67	12.83	12.50	12.50	12.50	16.50
3	17.00	16.00	14.00	20.50	17.00	15.50	13.67	12.83	12.50	12.50	12.50	15.50
4	16.50	20.00	14.67	19.00	17.00	15.50	13.67	12.83	12.50	12.50	12.50	14.75
5	16.50	18.00	17.00	20.00	17.00	15.50	13.67	12.67	12.50	12.50	12.50	14.33
6	16.00	17.00	16.00	29.00	17.00	15.50	13.67	12.67	12.50	12.50	12.50	14.00
7	16.00	17.00	16.00	26.00	17.50	15.50	13.67	12.67	12.50	12.50	12.50	13.75
8	15.50	18.00	19.00	23.00	18.25	15.00	13.50	12.67	12.50	12.50	12.50	13.50
9	15.00	17.00	18.00	21.00	18.00	15.00	13.50	12.67	12.50	12.50	12.50	13.50
10	14.75	16.00	17.00	20.00	17.67	15.00	13.50	12.50	12.75	13.00	12.50	13.25
11	14.50	16.00	27.00	19.00	17.67	14.67	13.50	12.50	13.75	12.75	12.50	13.00
12	14.25	18.50	21.00	19.00	18.00	14.33	13.50	12.50	13.50	12.75	12.50	13.00
13	14.25	17.00	19.00	18.00	18.00	14.33	13.33	12.50	13.33	12.75	12.50	13.00
14	14.00	17.00	18.00	17.50	18.00	14.33	13.33	12.50	13.00	12.75	12.50	13.83
15	14.00	16.00	17.00	17.00	17.67	14.33	13.33	12.50	13.00	12.75	12.50	13.83
16	16.50	16.00	19.00	17.00	18.33	14.33	13.33	12.50	12.75	12.75	12.50	13.50
17	15.25	15.50	19.00	17.00	18.33	14.33	13.33	12.50	12.75	12.75	12.50	13.00
18	14.00	15.50	21.00	16.50	17.50	14.33	13.33	12.50	12.75	12.75	12.50	13.00
19	14.75	15.50	22.00	16.50	17.00	14.33	13.33	12.50	12.75	12.75	12.50	13.00
20	14.50	15.00	20.00	16.50	17.00	14.33	13.33	12.50	12.75	12.50	12.50	13.00
21	14.50	15.00	23.00	16.50	16.67	14.00	13.00	12.50	12.75	12.50	12.50	14.00
22	14.25	15.00	21.00	17.00	16.50	14.00	13.00	12.50	12.75	12.50	12.50	15.50
23	14.25	15.00	20.00	18.00	16.50	14.00	13.00	12.50	12.75	12.50	12.50	15.50
24	14.25	14.67	19.00	18.00	16.00	14.00	13.00	12.50	12.75	12.50	12.75	15.50
25	13.00	14.67	19.00	18.00	15.75	13.83	13.00	12.50	12.75	12.50	12.75	16.00
26	13.50	14.67	18.00	17.00	15.50	13.83	13.00	12.50	12.75	12.50	13.50	14.50
27	19.00	14.50	18.00	17.50	15.25	13.83	13.00	12.50	12.75	12.50	16.00	14.25
28	16.00	14.50	18.50	17.50	15.25	13.67	13.00	12.50	12.75	12.50	17.50	14.00
29	16.00	.....	19.00	17.00	15.67	13.67	13.00	12.50	12.75	12.50	15.00	14.00
30	16.00	.....	20.00	17.00	15.67	13.67	13.00	12.50	12.75	12.50	16.00	14.00
31	16.00	.....	20.00	.....	15.67	.....	13.00	12.50	.....	12.50	.....	14.00

Daily gage height of Sacramento River at Tehama Bridge, California, for 1894.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	14.00	.....	3.58	7.00	3.33	3.00	1.33	0.17	0.17	0.75	0.83	1.00
2	14.50	.....	5.33	6.83	3.33	3.00	1.25	.17	.17	.50	.83	.83
3	14.50	.....	4.50	6.33	3.17	3.00	1.25	.17	.17	.42	.50	.75
4	14.00	.....	4.08	6.08	3.08	3.25	1.17	.17	.17	.33	.50	.75
5	13.75	.....	3.83	5.75	3.00	4.00	1.17	.17	.17	.33	.58	1.17
6	13.65	.....	4.92	5.42	3.00	3.50	1.17	.17	.17	.25	.58	3.92
7	13.00	.....	4.08	5.08	3.00	3.17	1.08	.17	.17	.25	.58	2.75
8	13.00	.....	4.50	5.00	3.08	3.08	1.00	.17	.17	.25	.58	6.42
9	13.00	.....	5.58	4.92	3.33	2.92	.92	.17	.17	.25	.50	6.83
10	12.75	.....	5.42	4.83	3.17	2.83	.92	.17	.17	.25	.50	4.58
11	12.75	.....	4.33	5.00	3.08	2.75	.92	.17	.17	.25	.50	3.08
12	12.75	.....	4.42	4.83	3.08	2.67	.83	.17	.17	.25	.42	2.92
13	12.75	.....	4.33	4.42	3.00	2.67	.83	.17	.17	.25	.42	2.25
14	16.00	.....	4.42	4.33	3.08	2.50	.75	.17	.17	.25	.42	1.75
15	29.00	.....	4.50	4.25	3.92	2.42	.75	.17	.17	.25	.50	1.75
16	23.00	.....	5.08	4.00	3.42	2.50	.75	.17	.17	.25	.50	1.75
17	20.00	.....	6.25	3.92	3.08	2.50	.75	.17	.17	.25	.50	2.08
18	18.50	.....	5.92	3.67	3.00	2.58	.75	.17	.17	.33	.50	6.00
19	17.00	.....	5.75	3.58	3.00	2.50	.75	.17	.17	.58	.50	9.00
20	21.00	.....	5.00	3.67	3.08	2.25	.67	.17	.17	.92	.42	8.42
21	19.00	.....	4.75	3.58	3.00	2.08	.67	.17	.17	2.42	.42	15.67
22	19.50	.....	4.33	3.50	2.92	1.83	.58	.17	.17	1.42	.42	11.92
23	19.50	.....	4.08	3.67	2.92	1.67	.58	.17	.17	1.17	.42	7.42
24	18.50	.....	3.92	3.58	2.92	1.67	.58	.17	.17	4.33	.50	5.25
25	17.33	3.83	3.83	3.58	2.92	1.67	.50	.17	.17	2.33	.50	4.17
26	16.50	3.50	4.00	3.67	2.92	1.50	.50	.17	.17	1.58	.50	3.42
27	16.75	3.42	4.17	4.00	3.08	1.50	.42	.17	.17	1.33	.42	2.92
28	16.50	3.58	4.50	3.42	3.17	1.50	.33	.17	.17	.92	1.50	2.83
29	16.00	.....	5.00	3.33	2.92	1.42	.25	.17	.17	.83	1.58	3.75
30	16.50	.....	5.50	3.33	2.92	1.42	.25	.17	.75	.75	.83	5.25
31	16.00	.....	6.42	.....	2.92	.....	.17	.17	.....	.67	.....	5.08

SAN JOAQUIN BASIN, CALIFORNIA.

This great river basin, occupying the southern part of the Great Valley of California, is drained by some of the most notable rivers of California, important from the standpoint both of irrigation and of water power. These streams, rising in the high Sierras, flow westerly and, leaving their narrow canyons, enter upon the broad valley, where, with lessened descent, each builds for itself a delta, over which the stream from time to time shifts its channel or subdivides into numerous sloughs. The railroads and principal towns of the valley are well out from the foothills, so that the principal bridges are at points below the mouths of the canyons and the headworks of the important irrigating canals. In order to obtain the full discharge of the streams it is essential to go back from the railroads up into the canyons, where the rivers flow in a single channel between well-defined banks.

The Southern Pacific Railroad Company has maintained at its bridge crossings series of readings of river height extending over a number of years, and although the river sections at these bridges are not always favorable for discharge measurements, and the full flow of the river, especially in low water, does not pass under the bridge, yet in taking up work in this part of the country it was deemed desirable to attempt to utilize these long records of river height by making series of measurements by which they might be interpreted into quantities. As the work expands the attempt will be made to establish stations higher up on the river at more suitable localities; but as this involves considerable expense, both in time and for transportation, the development must proceed slowly.

The principal stations on the San Joaquin and its tributaries in operation in 1894 were at Bakersfield, Kern County; Kingsburg, Tulare County; Herndon, Fresno County; Modesto, Stanislaus County, and Lodi, San Joaquin County.

TEJON STATION, ON TEJON HOUSE CREEK.

Tejon House Creek rises in the mountains at the southern or upper end of the San Joaquin Valley, south of Tehachapi Pass, and flows in a general westerly and southwesterly direction, the waters being finally lost in the gravels of the open valley, or, in time of flood, passing out upon the plain, flow into the marshes about Kern Lake.

Measurements of this creek were made during 1894 by Mr. J. B. Lippincott, near the Tejon ranch house. The drainage basin above this point is estimated to be about 17 square miles. It rises in altitude from 1,400 feet at the ranch house, 2 miles below the mouth of the canyon, to 9,214 feet on Tehachapi Mountain. The average rainfall at Fort Tejon, whose elevation is 2,300 feet, is 18 inches, and at the ranch house, 12 inches. The underlying rocks of the catchment basin are granitic, and the soils mainly clays, the conditions being such as to produce a considerable run-off. The following are the results of measurements made by Mr. Lippincott during 1894:

	Second-feet.
January 10	60
January 21	60
March 4	80
June 24	6.5
September 5	.9

The gage at this point is read by Mr. R. M. Pogson, agent of the Tejon ranches, Bakersfield, Cal. These observations are made as often as convenient, and cover all decided changes in the amount of water.

The next stream of considerable size to the north is Caliente Creek, along whose course the Southern Pacific Railroad follows from Tehachapi Pass down into the San Joaquin Valley. This stream fluctuates widely, and it has not been deemed practicable to establish a station on it. The State engineer of California attempted to make a series of measurements, but was compelled to abandon the project, although estimates of its discharge were prepared covering the period from November, 1878, to October, 1894. The stream near the railroad station of Caliente is dry for the greater part of the year. The drainage basin above this point is largely covered with sandy soil, gently undulating, and not favorable for a large run-off, the discharge taking place mainly in time of flood.

BAKERSFIELD STATION, ON KERN RIVER.

Measurements of the discharge of Kern River above the head of the canals have been made for a number of years under the direction of Mr. Walter James, chief engineer of the Kern County Land Company,

for the purpose of obtaining the information necessary to the operation of the great system of canals irrigating the Kern delta. Data are not at hand giving the daily height of water or the relation of height to discharge, but the following figures given by Mr. James show the total flow of the river upon the days named:

Flow of Kern River at Bakersfield, California, in 1893.

	Second-feet.
April 19	2,058
April 21	2,223
May 22	4,776
June 6	5,547
June 13	5,619
June 14	5,068
June 20	4,899
June 24	4,142
July 7	3,821
September 29	486
October 24	519
November 7	519
November 20	467

KINGSBURG STATION, ON KINGS RIVER.

This station is located at the Southern Pacific Railroad bridge, 1 mile south of Kingsburg, Cal. The station is an old one, and was examined by Mr. Arthur P. Davis on January 10, 1895. The observer is Mr. Alf. Thompson, watchman. It is distant about 500 feet from the watchman's house. The gage is a vertical plank, fastened to a bridge pier, painted white, and divided into feet and inches. Measurement of discharge was made from the watchman's boat, suspended from the wagon bridge, about 200 feet below the railroad bridge. The channel is too badly broken up for gaging from either bridge. Above this bridge the following canals are taken out:

Name of canal.	Capacity.
	Second-feet.
Fresno	1,500
Seventy-six	600
Fowler Switch	600
Kingsburg	600
Total	3,300

Daily gage height of Kings River at Kingsburg, California, for 1893.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1.....	4.50	7.50	4.50	6.50	5.00	10.33	9.33	4.17	2.33	2.33	2.67	2.33
2.....	4.33	6.33	4.42	6.67	5.25	10.92	9.50	4.17	2.25	2.50	2.58	2.17
3.....	4.08	5.83	4.33	6.33	5.33	11.67	9.50	4.17	2.17	2.33	2.58	2.17
4.....	4.17	5.50	4.17	6.25	6.00	12.08	9.08	4.17	2.50	2.25	2.58	2.17
5.....	3.83	6.25	4.75	6.17	6.83	12.33	8.83	4.08	3.33	2.33	2.67	2.17
6.....	3.83	6.00	4.83	6.17	6.83	12.08	8.50	4.00	2.83	2.25	2.92	2.08
7.....	3.83	5.33	4.58	6.08	7.33	11.92	8.33	4.00	2.58	2.25	2.75	2.08
8.....	3.75	5.17	4.33	5.50	7.92	11.50	8.17	3.75	2.50	2.17	2.67	2.08
9.....	3.67	9.83	6.17	5.08	7.75	11.58	8.50	3.75	2.50	2.17	2.92	2.08
10.....	3.83	11.50	5.25	5.17	8.75	11.75	8.00	3.50	2.50	2.17	2.50	2.08
11.....	3.83	8.17	4.83	5.25	9.33	12.00	7.17	3.33	2.33	2.25	2.00	2.08
12.....	4.00	7.00	5.83	5.00	9.92	11.83	6.83	3.42	2.25	2.25	2.00	2.08
13.....	3.67	6.83	5.75	4.83	10.25	10.42	6.67	3.33	2.17	2.25	2.00	2.08
14.....	3.67	6.17	5.25	4.67	10.75	9.75	6.33	3.42	2.08	2.25	1.92	2.08
15.....	3.33	6.08	5.67	5.00	11.00	10.00	5.75	3.42	2.08	2.25	1.92	2.08
16.....	3.17	5.67	5.67	5.00	10.83	10.50	6.08	3.17	2.08	2.25	1.92	2.08
17.....	5.00	5.58	5.33	5.00	10.58	10.67	6.08	3.00	2.08	2.25	1.92	2.08
18.....	4.33	5.42	5.08	5.08	9.58	10.75	6.17	2.83	2.50	2.25	1.92	2.08
19.....	4.00	5.25	5.00	5.17	8.83	10.17	6.00	2.83	2.50	2.33	1.92	2.08
20.....	3.58	5.25	6.17	5.25	8.75	9.75	6.00	2.67	2.58	2.50	2.25	2.08
21.....	3.50	5.25	11.75	5.75	8.58	9.58	6.00	2.58	2.67	2.50	2.33	.....
22.....	3.25	5.17	8.33	5.83	8.58	9.75	6.00	2.42	2.67	2.50	2.50	2.08
23.....	3.92	5.17	7.17	6.00	9.00	9.50	5.67	2.33	3.67	2.42	2.33	2.17
24.....	3.83	5.17	6.25	5.58	9.75	9.17	5.67	2.33	2.50	2.42	2.00	3.50
25.....	3.83	5.00	6.00	5.17	9.25	9.17	5.67	2.25	2.50	2.33	2.08	3.25
26.....	3.83	5.08	6.42	5.00	8.75	9.08	5.75	2.25	2.50	2.33	2.17	3.17
27.....	4.00	5.00	6.58	5.00	8.83	9.00	5.75	2.25	2.42	2.33	2.33	2.67
28.....	6.25	4.00	6.75	5.33	9.08	9.00	5.00	2.42	2.42	2.67	2.25	2.58
29.....	5.00	.....	6.92	5.00	9.50	8.92	4.33	2.42	2.33	2.50	2.33	2.58
30.....	4.75	.....	6.75	4.67	9.75	9.00	4.25	2.50	2.25	2.67	2.58	2.50
31.....	11.25	.....	6.50	.....	10.08	.....	4.17	2.50	.....	2.58	.....	2.50

Daily gage height of Kings River at Kingsburg, California, for 1894.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1.....	2.50	2.00	3.25	4.83	5.25	6.83	2.33	2.75	2.75	2.67	2.92	3.25
2.....	2.50	1.92	3.33	5.08	5.42	6.25	2.33	2.67	2.50	3.33	2.92	3.17
3.....	3.33	1.92	4.08	5.42	5.58	5.83	5.00	2.67	2.33	3.25	2.92	3.08
4.....	3.17	1.92	4.17	5.42	5.83	5.92	4.75	2.67	2.25	3.58	2.92	3.00
5.....	2.83	1.92	2.92	5.42	6.75	6.00	4.58	2.67	2.17	4.00	2.92	3.00
6.....	2.50	1.92	2.83	5.33	7.00	6.00	4.58	2.67	2.17	4.17	2.87	3.17
7.....	2.50	1.92	3.00	5.42	7.83	5.75	4.42	2.50	2.17	4.12	2.83	4.25
8.....	2.25	1.92	2.83	5.67	8.67	5.25	4.50	2.42	2.17	4.00	2.83	4.75
9.....	2.00	2.00	2.58	5.92	9.00	5.08	4.33	2.42	2.12	3.75	2.75	4.92
10.....	1.92	2.67	2.75	6.08	9.00	5.25	3.83	2.33	2.12	3.67	2.67	4.58
11.....	1.92	4.33	2.83	6.58	8.75	5.25	3.58	2.33	2.08	3.58	2.62	4.83
12.....	1.83	4.00	2.83	6.33	8.42	5.08	3.75	2.25	2.00	3.50	2.62	4.58
13.....	1.92	3.83	3.25	6.00	7.50	4.75	3.25	2.25	2.00	3.33	2.67	4.33
14.....	1.92	3.58	3.58	5.92	7.25	4.50	3.00	2.17	2.00	3.25	2.75	4.33
15.....	1.92	3.33	3.83	6.25	7.42	4.58	2.83	2.17	2.00	3.17	2.75	4.42
16.....	3.00	2.75	4.00	5.83	6.92	4.75	2.50	2.17	2.96	3.08	2.58	4.33
17.....	4.67	4.50	4.83	5.58	6.92	4.75	2.50	2.17	1.96	2.92	2.33	4.33
18.....	4.00	3.50	4.75	5.00	6.50	4.75	2.50	2.12	1.96	2.67	2.58	4.17
19.....	4.17	3.08	4.33	5.00	6.17	4.75	2.25	2.12	1.92	2.67	2.58	4.17
20.....	3.92	3.33	4.58	5.33	6.07	4.58	2.58	2.08	1.00	2.92	2.58	5.92
21.....	3.83	5.92	3.92	5.50	6.00	4.33	2.67	2.08	2.08	3.00	2.67	6.08
22.....	4.33	5.83	3.75	5.58	5.83	4.33	2.67	2.08	2.17	3.25	2.67	5.17
23.....	3.00	4.58	3.50	5.50	6.17	4.50	2.75	2.08	2.33	3.33	2.67	5.17
24.....	2.50	4.00	3.08	5.17	7.17	4.33	2.67	2.08	2.33	3.50	2.75	5.17
25.....	2.25	3.58	3.33	5.42	8.00	4.42	5.83	2.08	2.25	3.42	2.75	4.67
26.....	2.17	3.33	3.83	6.00	7.75	4.33	2.92	2.00	2.29	3.50	2.75	4.33
27.....	2.08	3.17	4.33	5.67	6.83	4.25	3.00	2.00	2.33	3.33	2.92	4.33
28.....	2.00	3.08	4.58	5.25	6.42	4.08	2.92	2.00	2.42	3.17	2.92	4.83
29.....	2.00	.....	4.58	4.92	6.17	4.17	2.83	2.00	2.42	3.17	2.96	5.17
30.....	1.92	.....	4.83	4.83	6.17	4.25	2.83	2.17	2.58	3.08	2.96	6.33
31.....	1.92	.....	4.83	.....	7.00	.....	2.75	2.83	.....	3.00	.....	5.67

HERNDON STATION, ON SAN JOAQUIN RIVER.

The gage at this station is located on the northeast corner of the middle pier of the Southern Pacific Railroad bridge, 1 mile north of Herndon, Cal. The station is an old one, and was examined by Mr.

Arthur P. Davis on January 9, 1895. The observer is Mr. George G. Nelson, Borden, Madera County, Cal. The station is distant from the observer's house about 500 feet. The gage is a vertical plank fastened to the bridge pier. It can be read from the bridge. A measurement of discharge made from the wagon bridge, about 800 feet above, gave on the date above named a total flow of 1,995 second-feet.

Daily gage height of San Joaquin River at upper crossing, Herndon, California, for 1893.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1.....	3.50	6.50	3.58	6.83	5.67	7.75	8.00	4.83	3.67	2.08	1.67	2.33
2.....	3.17	5.33	3.58	6.58	5.83	9.00	8.25	5.00	3.58	2.08	1.67	2.33
3.....	3.00	5.00	3.50	6.33	5.75	10.50	8.42	5.00	3.58	2.25	1.67	2.33
4.....	2.83	4.50	3.67	6.00	5.92	11.33	8.50	5.00	3.50	2.17	1.58	2.33
5.....	2.58	6.92	3.67	6.20	6.33	11.50	8.17	5.00	3.50	2.00	1.58	2.25
6.....	2.42	5.00	3.83	6.50	6.50	11.42	7.75	5.00	3.50	2.00	1.50	2.33
7.....	2.33	4.50	4.00	6.17	6.75	11.25	7.25	5.00	3.58	1.83	1.50	2.17
8.....	2.00	4.42	4.00	5.83	7.33	10.50	7.00	5.00	3.58	1.75	1.50	2.17
9.....	2.00	8.50	5.25	5.25	7.67	10.67	7.50	4 92	3.50	1.75	1.50	2.17
10.....	2.00	7.83	4.42	5.33	8.00	10.50	7.58	4.83	3.42	1.67	1.50	2.17
11.....	2.17	6.50	4.58	5.08	8.67	10.75	7.33	4.67	3.42	1.67	1.50	2.17
12.....	2.33	6.00	5.50	5.00	9.33	10.33	7.00	4.50	3.33	1.58	1.50	2.00
13.....	2.33	5.67	5.00	5.00	9.50	10.00	6.67	4.25	3.33	1.92	1.42	2.00
14.....	2.17	5.17	4.50	5.25	10.33	9.50	6.25	2.17	3.17	2.00	1.42	2.00
15.....	2.00	4.83	5.17	5.25	10.50	9.17	6.00	4.00	3.17	2.00	1.42	2.00
16.....	2.00	4.58	4.83	5.08	10.25	9.00	6.00	4.00	3.00	1.92	1.42	2.00
17.....	4.50	4.58	4.50	5.00	10.00	8.83	5.83	4.17	3.00	1.92	1.33	2.00
18.....	3.50	4.50	4.33	4.83	9.75	8.50	6.25	4.17	2.83	1.83	1.33	2.00
19.....	3.25	4.50	4.33	5.00	8.50	8.42	6.50	4.00	2.75	1.83	1.33	2.58
20.....	3.17	4.33	8.50	5.33	8.17	8.17	6.67	4.00	2.75	1.83	1.33	2.50
21.....	3.00	4.25	12.00	5.42	7.75	8.00	6.50	4.00	2.67	1.75	1.33	2.50
22.....	2.75	4.25	8.00	6.00	8.00	8.00	6.25	3.83	2.58	1.75	1.33	2.50
23.....	3.00	4.00	6.50	6.67	8.17	8.17	6.00	3.75	2.58	1.75	1.33	2.50
24.....	2.50	4.00	6.00	6.17	8.50	8.33	6.00	3.75	2.50	1.67	1.33	3.00
25.....	2.50	4.08	5.50	6.00	8.17	8.00	6.17	3.58	2.50	1.67	1.33	2.75
26.....	2.42	4.00	5.67	5.75	8.00	7.83	6.00	3.83	2.33	1.67	1.83	2.50
27.....	3.50	3.83	6.83	5.67	7.75	7.67	6.00	3.75	2.33	1.83	2.17	2.67
28.....	5.50	3.67	6.58	5.50	7.83	7.42	6.17	3.75	2.25	1.75	2.50	2.67
29.....	4.00	.....	6.83	5.17	8.00	7.50	5.83	3.67	2.25	1.75	2.83	2.50
30.....	4.17	.....	6.67	5.00	8.17	7.67	5.50	3.75	2.08	1.67	2.50	2.33
31.....	9.00	.....	6.75	.....	8.00	.....	5.00	3.75	.....	1.75	.....	2.33

Daily gage height of San Joaquin River at upper crossing, Herndon, California, for 1894.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1.....	2.50	6.67	2.83	4.83	4.42	6.50	4.50	3.25	3.33	2.17	3.00	2.58
2.....	2.58	6.58	3.33	5.00	4.75	6.17	4.50	3.17	3.17	2.42	2.92	2.42
3.....	3.00	6.50	3.83	5.17	5.00	5.83	4.42	3.33	3.17	2.50	2.92	2.42
4.....	2.83	6.50	3.50	5.00	5.58	5.67	4.42	3.33	3.17	2.50	2.83	2.42
5.....	2.75	6.42	3.33	5.00	6.33	5.50	4.42	3.42	3.08	2.58	2.83	2.50
6.....	2.75	6.42	3.33	5.08	6.58	5.50	4.50	3.33	3.08	2.83	2.67	2.67
7.....	2.58	6.42	3.25	5.00	7.00	5.17	4.50	3.33	3.00	3.00	2.67	2.92
8.....	2.58	6.46	3.25	5.33	7.50	4.83	4.42	3.25	3.00	3.00	2.67	3.33
9.....	2.50	8.25	3.08	5.50	8.58	4.83	4.42	3.25	3.00	3.00	2.58	3.75
10.....	2.50	12.50	5.50	6.00	8.50	5.00	4.33	3.17	3.00	2.75	2.50	3.33
11.....	2.50	12.00	3.33	6.83	8.00	5.00	4.33	3.17	2.83	2.67	2.50	3.00
12.....	2.50	10.33	3.33	6.25	7.67	5.00	4.33	3.08	2.83	2.50	2.50	2.83
13.....	2.50	9.08	4.00	5.83	7.50	4.50	4.17	2.83	2.75	2.50	2.50	2.83
14.....	2.33	8.67	4.25	5.50	7.00	6.50	4.17	2.75	2.67	2.50	2.50	2.75
15.....	2.33	8.08	4.00	5.33	6.75	4.42	4.17	2.58	2.67	2.42	2.42	2.67
16.....	3.50	9.00	4.17	5.08	6.50	5.00	4.25	2.67	2.58	2.25	2.42	2.83
17.....	3.17	9.25	4.50	5.00	6.42	5.25	4.00	2.67	2.58	2.25	2.42	2.83
18.....	3.00	12.00	4.33	5.00	6.17	5.50	3.92	2.58	2.58	2.25	2.42	3.00
19.....	2.75	15.67	4.33	4.83	6.00	5.42	3.83	2.58	2.58	2.17	2.42	3.17
20.....	2.75	17.33	4.17	5.00	5.75	5.17	3.83	2.50	2.50	2.17	2.42	5.50
21.....	2.83	17.00	3.83	5.33	5.50	5.00	3.75	2.50	2.50	2.58	2.42	5.00
22.....	2.58	16.33	3.75	5.25	5.33	4.83	3.75	2.50	2.42	2.92	2.42	4.83
23.....	3.33	15.67	3.42	5.17	5.50	4.50	3.58	2.50	2.42	3.00	2.42	4.92
24.....	3.33	15.00	3.50	5.00	6.50	4.50	3.50	2.50	2.33	3.33	2.33	4.50
25.....	3.17	14.67	3.50	4.83	6.67	4.42	3.42	2.50	2.17	3.42	2.33	3.75
26.....	3.17	13.00	3.58	5.58	7.00	4.83	3.42	2.50	2.08	3.50	2.33	3.50
27.....	3.00	13.00	4.00	5.00	7.17	5.00	3.33	2.50	2.00	3.50	2.33	3.33
28.....	3.00	12.67	4.50	4.92	6.00	5.25	3.42	2.58	2.00	3.42	2.50	4.00
29.....	3.00	.....	4.74	5.00	5.75	5.17	3.42	3.75	2.00	3.25	2.50	4.50
30.....	2.92	.....	4.83	4.58	5.83	4.67	3.42	4.33	2.00	3.17	2.58	5.75
31.....	2.92	.....	5.00	.....	6.50	.....	3.25	3.83	.....	3.00	.....	4.00

MODESTO STATION, ON TUOLUMNE RIVER.

Observations of river height at the railroad bridge crossing Tuolumne River, 1 mile south of Modesto, have been kept by the Southern Pacific Railroad Company for a number of years. On November 12, 1889, William P. Trowbridge, jr., hydrographer of the Irrigation Survey, under instructions from William Ham. Hall, supervising engineer, began a series of measurements at this point, both for the purpose of determining the flow of the stream and for experimentally ascertaining the best methods and apparatus for making velocity measurements upon rivers of this class. In this work he was delayed by the unfavorable weather then prevailing, rain continuing from November 17 to January 1, 1890, with hardly a break, much of the time being accompanied by violent winds. The first work was to place in position a permanent gage, this being attached to the central pier of the railroad bridge. Under orders from William Hood, chief engineer of the Southern Pacific Company, the railroad employees furnished a well-painted gage and secured it in position, under Mr. Trowbridge's supervision. The bridge tender, G. G. Nelson, was also instructed to furnish daily readings of the height of water, copies of his observations being sent to the railroad office and to Mr. Hall.

A one-half-inch cable was stretched across the river at a point about 200 feet above the bridge, this being a distance sufficiently great to be removed from the influence of the bridge piers. At this point the stream is about 220 feet wide, and has an average depth of from 5 to 7 feet at ordinary stages, and from this up to 20 feet in times of flood. A small topographic map was then made of the vicinity, by means of transit and stadia, and cross sections were run at various distances above and below the station in order to furnish data for the study of the stream bed in that vicinity. Longitudinal sections were also run, and bench marks placed at intervals of 500 feet for a distance of 1,000 feet above and below the section. Small temporary gages were placed at the extreme ends of this line for the purpose of obtaining the slope of the river at its various stages, by means of simultaneous gage readings. All bench marks were referred to the plane of the zero mark of the gage on the bridge, this being the reference plane for all work at this locality. This zero mark was referred to the railroad track.

A light, safe catamaran was constructed, capable of being taken apart and shipped to any point, and from this velocity measurements were made. It was determined, however, that the method of obtaining velocity measurements from shore, or the cable and traveling apparatus, should be tried experimentally. This, as devised by Mr. Hall and put into operation by Mr. Trowbridge, consists of two cables stretched across the stream; from one of these—the lower—the meter is suspended by suitable cords and pulleys, and held from being swept downstream by a stay line which runs to the upper cable. A brief descrip-

tion of this method is given in the Eleventh Annual Report of the United States Geological Survey, Part II, Irrigation, pages 16 to 18. It was reported that a number of complete measurements were made, but the results of these were not forwarded to the Washington office. These measurements were necessarily made rapidly, as the river is subject to sudden rises on account of the warm rains falling on the snow in the mountains. Velocity observations were taken at every 20 feet across the river, and at intervals of 2 feet in the vertical, the meter being usually run for two minutes for each observation. Work at this point was continued until February 2, 1890.

This station was inspected on January 8, 1895, by Mr. Arthur P. Davis, who at that time made a measurement of discharge, showing that for a height of 7.7 feet the river was flowing at the rate of 3,003 second-feet. He states that the gage consists of a vertical plank passing from the south side of the middle pier of the railroad bridge, and divided into feet and halves. It can be easily read from the south shore or from the wagon bridge, 200 feet to the west. The river measurement was made from the wagon bridge just below the railroad bridge. At that point the channel is sandy, but favorable for measurements at low water and at medium high stages. In extreme flood, however, the river leaves its banks. Mr. J. B. Lippincott states that the old gage on the Tuolumne was set in 1872 by A. P. Guppy and J. T. Reed. The new gage, now standing in the river, set in 1889 by William P. Trowbridge, jr., reads 1 foot higher than the old gage; that is to say, 2 feet on the old gage would read 3 feet on the new.

Tuolumne River, during the spring floods, has a daily variation, due to the melting of snow in the mountains. The low stage is at about 9 a. m., and the high at about 3 p. m. J. T. Reed, the present observer, records the height of water about 3 p. m.

The velocity of the river at this point is largely controlled by the height of the San Joaquin, into which it empties. When the latter is low, and local rains occur in the Tuolumne, the velocity is relatively high; that is to say, with the same height of gage different velocities may be observed.

Daily gage height of Tuolumne River at Modesto, California, for 1893.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1.....	8.17	12.00	7.00	10.33	8.33	14.67	13.92	7.42	4.92	2.67	1.75	5.50
2.....	7.83	9.08	6.75	10.50	8.67	15.75	13.50	7.33	4.75	2.58	1.75	6.42
3.....	7.67	9.00	6.75	10.33	9.25	16.92	14.33	7.33	4.58	2.58	1.67	5.58
4.....	7.50	8.17	6.67	10.17	10.17	17.58	14.42	7.33	4.50	2.50	1.67	5.92
5.....	7.25	13.98	6.75	9 83	10.50	17.83	13.92	7.17	4.33	2.50	1.67	4.58
6.....	7.17	10.08	6.67	12.17	10.00	18.08	13.42	6.92	4.08	2.50	1.67	4.33
7.....	7.08	7.00	6.42	10.42	10.58	17.92	12.33	6.75	4.00	2.42	1.75	4.17
8.....	6.83	8.00	6.00	9.58	10.75	17.58	11.75	6.58	3.92	2.42	1.83	3.92
9.....	6.58	19.08	6.17	9.08	11.83	16.67	12.25	6.33	3.92	2.33	2.17	3.43
10.....	6.50	16.00	5.83	8.75	12.67	17.00	12.58	6.17	3.83	2.33	2.08	3.17
11.....	6.33	11.00	5.75	8.67	14.17	17.42	12.50	6.00	3.75	2.33	2.00	3.08
12.....	6.17	10.00	10.75	8.25	15.25	17.83	11.58	5.92	3.50	2.33	2.00	3.00
13.....	6.00	10.08	7.75	8.08	15.75	18.00	16.92	5.83	3.33	2.42	2.17	3.17
14.....	5.33	9.08	6.83	8.00	16.58	16.17	10.50	5.75	3.17	2.42	2.00	3.42
15.....	5.58	.....	13.50	7.92	16.42	14.08	10.17	5.58	3.17	2.33	1.83	3.08
16.....	6.50	.....	9.83	8.33	16.58	14.33	10.33	5.50	3.08	2.33	1.75	2.92
17.....	10.58	7.83	8.17	8.75	15.17	15.58	10.58	5.42	3.08	2.33	1.75	3.00
18.....	7.83	7.67	6.83	8.50	15.00	15.75	10.50	5.25	3.00	2.25	1.67	3.00
19.....	6.67	7.50	7.83	8.58	13.42	15.17	10.33	5.08	3.00	2.25	1.67	2.92
20.....	6.50	7.50	10.83	8.75	12.25	14.33	10.42	5.00	3.08	2.25	1.58	2.83
21.....	6.33	7.42	22.83	9.00	10.00	13.58	10.17	4.92	3.00	2.17	1.50	2.83
22.....	6.08	7.33	15.83	9.67	10.50	13.67	9.92	4.83	2.92	2.17	1.50	2.67
23.....	6.00	7.33	11.75	11.58	11.67	14.58	9.75	4.83	2.83	2.17	1.42	2.67
24.....	6.00	7.25	9.75	10.42	13.42	13.50	9.58	4.75	2.92	2.17	1.33	3.50
25.....	5.08	7.25	8.50	9.17	12.50	13.08	9.42	4.67	2.83	2.08	1.50	3.67
26.....	6.17	7.25	9.00	8.75	11.42	13.67	9.58	4.83	2.83	2.00	1.67	3.33
27.....	7.08	7.25	9.17	8.75	10.92	13.83	9.00	5.25	2.75	2.00	2.08	3.67
28.....	9.00	7.17	9.75	8.92	11.08	13.58	8.83	5.42	2.75	2.00	2.75	3.92
29.....	7.08	.....	10.67	8.75	12.25	13.67	8.58	5.25	2.67	1.83	7.50	3.83
30.....	7.08	.....	11.33	8.17	13.42	13.08	7.75	5.17	2.67	1.83	6.08	3.75
31.....	18.00	.....	10.42	.....	14.00	.....	7.58	4.92	.....	1.83	.....	3.58

Daily gage height of Tuolumne River at Modesto, California, for 1894.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1.....	3.83	5.33	7.07	8.33	8.92	15.50	10.67	4.92	3.83	1.50	3.25	1.83
2.....	3.92	5.33	7.25	8.58	9.67	13.83	10.42	4.83	3.33	1.58	3.08	1.75
3.....	4.68	5.17	7.33	9.25	9.58	13.33	9.67	4.75	3.25	1.67	3.00	1.58
4.....	4.75	5.17	6.67	9.08	9.83	13.50	9.83	4.67	3.17	1.67	2.75	1.58
5.....	4.50	5.33	6.50	9.25	10.83	11.75	9.92	4.58	3.00	1.75	2.67	1.75
6.....	4.50	5.00	6.42	9.58	12.17	11.83	9.25	4.50	2.83	1.83	2.50	1.83
7.....	4.08	5.00	6.50	10.25	13.83	10.83	9.17	4.42	2.75	1.75	2.50	3.50
8.....	4.17	5.00	6.42	10.58	14.67	9.83	9.00	4.25	2.67	1.83	2.42	4.58
9.....	4.17	4.92	6.25	10.92	15.75	9.67	8.50	4.00	2.50	1.83	2.33	6.00
10.....	4.08	15.50	6.33	11.83	16.17	9.75	8.50	3.92	2.33	1.92	2.33	6.58
11.....	4.00	6.92	6.50	13.08	15.83	10.08	8.25	3.75	2.17	1.58	2.25	5.83
12.....	4.00	5.92	6.42	11.58	16.67	9.50	8.08	3.67	2.08	1.58	2.08	5.33
13.....	4.25	5.75	7.08	10.92	15.17	8.67	7.83	3.58	2.00	1.58	2.00	4.42
14.....	4.42	5.50	7.42	11.08	14.25	8.67	7.50	3.58	2.00	1.58	1.92	4.08
15.....	4.58	5.42	7.50	11.50	14.83	9.67	7.42	3.42	1.92	1.50	1.92	3.75
16.....	14.42	6.58	7.50	10.50	12.33	10.08	7.17	3.25	1.92	1.67	1.83	3.42
17.....	7.50	5.00	8.83	9.42	11.17	11.25	6.92	3.17	1.83	1.67	1.75	3.33
18.....	6.00	5.67	7.75	8.67	11.08	11.83	6.75	3.17	1.75	1.58	1.75	3.50
19.....	6.25	7.58	7.50	8.83	11.92	11.92	6.50	3.08	1.67	1.58	1.67	6.42
20.....	5.58	21.83	7.42	10.33	11.33	9.83	6.42	3.08	1.67	1.50	1.58	17.50
21.....	16.17	23.00	6.83	11.33	10.67	9.92	6.00	3.00	1.58	2.50	1.58	7.08
22.....	7.42	10.83	6.50	11.17	10.50	10.17	5.92	3.00	1.58	3.50	1.58	15.17
23.....	6.58	9.58	6.33	10.75	10.58	9.83	5.92	2.92	1.50	4.75	1.50	11.83
24.....	6.33	7.67	6.33	10.50	12.67	10.50	5.67	2.92	1.50	4.17	1.50	7.67
25.....	5.83	7.33	6.50	9.75	14.00	10.67	5.58	2.83	1.42	5.67	1.50	7.33
26.....	5.50	7.17	6.83	11.17	15.08	10.58	5.50	2.83	1.42	5.25	1.50	6.17
27.....	5.42	6.92	7.50	10.08	14.00	10.17	5.42	2.75	1.33	5.17	1.50	5.75
28.....	5.42	6.92	7.50	8.75	13.17	10.33	5.50	2.75	1.33	4.58	1.42	10.75
29.....	5.17	.....	7.92	10.17	11.17	9.83	5.25	2.92	1.25	4.50	1.42	9.33
30.....	5.25	.....	8.50	8.17	11.42	10.42	5.08	4.08	1.58	3.92	1.75	8.25
31.....	5.33	.....	8.67	.....	13.75	.....	4.92	3.83	.....	3.50	.....	6.92

LODI STATION, ON MOKELUMNE RIVER.

This station is located 1 mile north of Lodi, at the railroad bridge of the Southern Pacific Company. This station is an old one, and was examined on January 6, 1895, by Mr. Arthur P. Davis. The observer is the bridge watchman. The gaging station is distant from the watchman's house about 600 feet. The gage is a vertical plank fastened to the south side of the middle pier and divided into feet and inches. It can be read from the bank at low water and from the bridge at all times. Gaging was made by lowering the meter through openings in the railroad bridge. The channel is very unfavorable for gaging. When the water is at the 8-foot mark, the current is broken and not at right angles to the bridge. About one-half mile above the railroad bridge is a wagon bridge which has no piers in the river and offers more favorable conditions for gaging.

Daily gage height of Mokelumne River at Lodi, California, for 1893.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1.....	9.00	16.00	8.00	14.17	12.00	15.50	13.00	10.67	10.00	7.83	7.00	7.50
2.....	8.50	14.33	8.00	14.00	12.50	15.83	13.50	10.75	9.83	7.67	5.50	7.67
3.....	8.50	13.00	8.00	13.50	12.50	11 33	13.83	10.50	10.00	7.58	4.83	8.00
4.....	8.50	12.50	8.00	13.00	13.00	16.17	13.83	10.50	10.00	7.50	4.83	6.50
5.....	8.50	12.00	8.83	12.67	13.50	16.50	13.50	10.50	10.17	7.50	4 83	6.00
6.....	8.50	12.00	7.83	12.33	13.33	16.50	13.00	10.50	10.17	7.50	4.83	5.83
7.....	8.50	11.17	7.83	12.08	13.42	16.33	12.67	10.50	10.25	7.42	4.83	5.50
8.....	8.50	10.00	7.83	11.83	13.58	16.17	12.50	10.50	10.33	7.33	4.83	5.50
9.....	8.50	13.42	7.83	11.50	14.00	16.33	12.33	10.50	10.50	7.33	4.83	5.50
10.....	8.50	15.33	7.83	11.33	14.50	16.50	12.00	10.50	10.50	7.42	4.83	5.50
11.....	8.50	14.00	10.50	11.00	15.00	16.25	11.83	10.50	10.33	7.50	4.83	5.50
12.....	8.50	12.33	8.00	11.00	15.50	16.33	11.00	10.50	10.50	7.50	4.83	5.50
13.....	8.50	12.00	8.00	10.50	16.00	16.25	11.50	10.50	10.50	7.83	4.83	5.50
14.....	8.50	11.17	10.00	10.33	16.50	15.33	11.58	10.50	10.50	8.00	4.83	5.50
15.....	8.58	10.00	9.00	10.17	17.00	14.17	11.67	10.50	10.50	8.00	4.83	5.50
16.....	11.00	10.00	10.00	10.00	16.50	14.83	11.50	10.50	10.25	7.50	4.83	5.50
17.....	12.00	10.00	9.00	10.00	16.67	14.83	11.33	10.50	10.17	8.00	6 33	5.50
18.....	9.50	9.50	11.00	10.00	16.50	15.00	10.83	10.50	10.17	8.17	7.00	5.50
19.....	8.50	9.00	13.00	10.33	15.33	15.33	10.83	10.50	10.00	8.17	7.33	5.50
20.....	8.50	9.00	19.58	10.67	14.17	15.00	10.58	10.50	9.83	8.17	7.33	5.50
21.....	8.50	8.83	7.00	11.00	14.00	14.83	10.83	10.50	9.50	8.17	7.00	5.50
22.....	8.33	8.83	15.50	12.00	13.50	14.50	11.67	10.50	9.50	8.17	6.17	5.83
23.....	8.17	8.83	14.50	13.00	12.83	14.33	10.83	10.50	9.50	8.17	5.83	6.00
24.....	8.00	8.67	13.00	14.00	13.33	14.42	10.00	10.33	9.83	8.25	5.83	6.50
25.....	8.00	8.67	13.33	13.50	14.50	14.42	9.25	10.25	9.50	8.25	6.00	7.00
26.....	8.83	8.50	12.00	12.33	14.33	14.33	9.50	10.33	9.33	8.25	7.50	7.00
27.....	12.00	8.33	12.50	12.00	13.50	14.33	10.50	8.50	8.25	7.83	10.50	6.00
28.....	11.33	8.33	12.00	13.00	14.00	14.00	10.83	9.00	8.17	7.75	8.00	5.83
29.....	10.50	.....	13.00	12.50	13.83	13.50	10.17	9.33	8.17	8.00	7.83	5.83
30.....	10.00	.....	13.50	12.00	14.33	13.33	10.33	10.00	8.08	8.17	7.50	5.50
31.....	10.00	.....	14.33	.....	14.58	.....	10.50	9.50	.....	8.00	.....	5.50

Daily gage height of Mokelumne River at Lodi, California, for 1894.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1.....	5.50	6.17	8.17	10.33	13.25	15.83	11.50	10.17	10.00	8.50	5.33	5.42
2.....	5.50	6.33	8.17	11.50	13.00	15.00	11.42	10.33	9.83	9.00	5.25	5.42
3.....	6.50	6.33	8.17	11.00	13.25	14.50	11.33	10.33	9.83	9.33	5.25	5.25
4.....	7.00	6.17	8.92	11.50	13.17	14.33	11.33	10.42	9.92	8.50	5.42	5.25
5.....	7.00	6.17	8.25	12.50	13.25	13.33	11.42	10.42	10.00	6.83	5.33	5.17
6.....	7.00	6.33	8.25	12.75	14.08	13.00	11.50	10.42	10.17	6.75	5.17	5.33
7.....	5.50	6.33	8.25	12.83	15.08	12.33	11.50	10.33	10.00	6.50	5.00	6.50
8.....	5.50	6.25	8.25	13.00	15.00	12.25	11.33	10.25	9.67	6.50	5.17	7.00
9.....	5.50	6.25	8.25	14.00	16.08	13.00	11.33	10.17	10.00	6.50	5.25	7.17
10.....	5.50	9.50	8.33	14.08	16.00	12.50	11.42	10.17	9.50	6.67	5.25	6.50
11.....	5.50	7.17	7.92	14.83	16.08	12.00	11.33	9.83	9.50	6.58	5.25	6.33
12.....	5.50	7.00	7.67	15.50	16.00	11.00	10.92	9.75	9.00	6.50	5.25	6.00
13.....	6.00	7.00	7.50	14.50	16.17	12.50	10.67	9.75	8.83	6.50	5.25	6.00
14.....	6.50	6.67	8.00	13.75	16.50	12.33	10.50	9.50	8.67	6.67	5.25	5.83
15.....	7.00	6.50	9.33	14.25	15.83	13.42	7.33	9.33	8.50	7.00	5.17	5.50
16.....	12.00	6.50	9.33	14.00	14.50	13.83	9.67	9.25	8.50	7.33	5.17	5.33
17.....	11.00	7.00	10.00	13.50	13.33	14.33	10.50	9.25	8.33	8.00	5.08	5.33
18.....	8.00	9.00	11.00	12.50	14.17	14.50	10.50	9.00	8.33	8.00	5.08	9.00
19.....	7.50	15.00	10.00	12.75	13.33	13.83	10.50	9.25	8.25	8.00	5.17	9.00
20.....	7.00	16.00	9.00	13.25	13.50	13.33	10.50	9.17	8.17	8.00	5.17	12.50
21.....	12.00	11.00	9.00	13.83	13.25	13.17	10.50	9.00	8.00	5.00	5.25	9.00
22.....	9.00	9.50	8.50	14.50	12.67	12.83	10.50	8.83	7.83	6.00	5.17	10.00
23.....	7.50	9.00	8.33	15.00	13.50	13.25	10.50	9.00	7.83	6.17	5.17	11.00
24.....	7.00	8.00	8.00	14.92	14.00	13.00	10.42	9.25	7.75	6.33	5.25	8.50
25.....	8.00	7.67	8.33	13.92	15.83	12.50	10.50	9.50	7.75	6.50	5.25	8.33
26.....	7.00	8.00	9.00	14.00	15.67	12.42	10.50	9.67	7.58	6.33	5.17	7.50
27.....	6.33	8.17	9.50	13.92	16.00	12.17	10.17	9.58	7.75	6.50	5.17	7.17
28.....	6.00	8.17	10.00	13.82	15.50	12.00	10.50	9.50	7.83	6.50	5.17	6.50
29.....	6.00	.....	10.50	12.00	14.83	11.50	10.25	9.33	7.75	5.83	5.42	6.33
30.....	6.00	.....	10.83	11.83	14.50	11.33	10.33	9.67	8.25	6.50	5.50	7.25
31.....	6.00	.....	11.00	.....	15.50	.....	10.50	9.83	.....	5.33	.....	7.50

SOUTHERN CALIFORNIA STREAMS.

The sources of the water supply of southern California are so widely scattered, and the streams themselves are often so small and difficult of access at points where measurements can be made, that, owing to expense, no systematic work has been done. The State engineer of California made a number of measurements at intervals, but, so far as can be ascertained, the results, though mentioned in reports, have not been prepared for publication. A preliminary reconnaissance was made in the fall of 1894 by this Survey, and a number of points were selected where measurements might be carried on, but the work has not advanced to a stage permitting of the publication of data, and these will be deferred until the next report.

POTOMAC BASIN, IN MARYLAND, VIRGINIA, AND WEST VIRGINIA.

A study of the Potomac River was begun in 1891, the field work being carried on by Mr. Cyrus C. Babb. Observations of river height were first made at Chain Bridge, about 3 miles above the city of Washington, and at later times reconnaissance and discharge measurements were made on some of the higher branches in order to obtain data of run-off from the catchment areas of different character under similar climatic conditions. In the fall of 1894 the matter was given more careful attention, and preparations were made for a thorough series of measurements during the succeeding year.

SPRINGFIELD STATION, ON SOUTH BRANCH OF POTOMAC.

Measurements of the South Branch of the Potomac are made at a point about 2 miles above Springfield, W. Va. Observations were begun on June 3, 1894, and continued until October 20, and were resumed in the succeeding year. Heights of water were measured by a wire gage, which is read by being drawn up along a scale divided into feet and tenths, attached to the guard rail of the bridge on the lower side. The channel is rocky and gravelly and is well adapted to discharge measurements, which are made from the bridge.

Daily gage height of South Branch River at Springfield, West Virginia, in 1894.

Day.	June.	July.	Aug.	Sept.	Oct.	Day.	June.	July.	Aug.	Sept.	Oct.
1	.....	4.1	4.2	3.7	3.6	17	4.65	.....	3.5	3.6	4.3
2	.....	4.1	4.1	3.7	5.1	18	4.9	.....	3.5	4.6	4.2
3	5.4	4.1	3.8	3.6	4.8	19	5.2	.....	3.8	6.7	4.1
4	5.2	4.0	3.8	3.6	4.5	20	4.65	.....	3.7	6.1	4.1
5	5.1	4.0	3.7	3.6	4.3	21	4.6	.....	3.7	5.0	.....
6	5.0	4.0	3.6	3.6	4.1	22	4.5	3.6	3.65	4.6	.....
7	5.5	4.0	3.5	3.5	4.0	23	.....	4.0	3.6	4.1	.....
8	6.4	4.0	3.5	4.0	3.9	24	4.4	4.0	3.6	4.1	.....
9	6.0	4.0	3.5	4.0	3.9	25	4.4	3.9	3.6	4.0	.....
10	5.7	3.9	3.5	3.9	3.8	26	4.3	3.8	3.6	3.9	.....
11	5.3	3.8	3.5	3.8	5.2	27	4.4	3.8	3.6	3.9	.....
12	5.1	3.8	3.5	3.8	5.1	28	4.4	3.8	3.6	3.7	.....
13	4.9	3.8	4.0	3.7	4.8	29	4.25	3.8	3.7	3.6	.....
14	4.85	3.7	3.8	3.7	4.6	30	4.2	3.7	3.7	3.6	.....
15	4.8	.....	3.7	3.6	4.5	31	.....	4.8	3.7	.....	.....
16	4.8	.....	3.6	3.6	4.4						

CUMBERLAND STATION, ON POTOMAC RIVER.

Observations of river height are taken at the West Virginia Central Railroad bridge, Cumberland, Md., about 200 yards below the dam on the Potomac. They were begun on June 11, 1894, and continued throughout that year. The gage is a vertical rod 10 feet long, bolted to the east end of the abutment of head gates above the dam. The channel consists of loose rocks and is not liable to change. The discharge measurements are made from the bridge.

Daily gage height of Potomac River at Cumberland, Maryland., in 1894.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	2.11	3.0	0.7	1.7	3.5	3.0	17	3.3	2.4	2.8	1.7	2.9	3.0	3.2
2	.....	2.11	3.0	.5	3.0	3.5	3.1	18	3.3	2.3	2.7	2.9	2.9	3.0	3.1
3	.....	2.11	3.1	.6	2.8	3.3	3.1	19	3.3	2.1	2.7	2.9	2.8	2.3	3.1
4	.....	2.10	3.1	.6	2.7	3.0	3.3	20	3.2	2.0	2.0	3.1	2.8	2.3	3.0
5	.....	2.10	2.9	.5	2.5	2.9	3.2	21	3.1	1.9	1.9	3.2	2.7	3.1	3.0
6	.....	2.10	2.8	1.0	2.3	3.0	3.2	22	3.1	1.5	1.9	3.2	2.7	3.0	3.0
7	.....	2.10	2.8	1.0	1.7	3.0	3.1	23	3.4	2.0	2.5	2.9	2.7	3.0	2.9
8	.....	2.10	2.6	1.1	1.6	3.0	3.1	24	3.4	3.0	3.0	2.9	2.2	3.0	3.1
9	.....	2.10	2.5	1.1	1.5	3.1	3.0	25	3.3	3.0	2.8	2.8	1.9	3.2	3.1
10	.....	2.10	2.1	1.1	1.9	3.1	3.0	26	3.3	2.9	2.5	2.7	1.8	3.1	3.0
11	3.5	2.09	2.0	1.0	2.0	3.2	3.2	27	3.3	2.9	1.9	2.7	1.7	3.0	3.0
12	3.4	2.08	2.1	1.0	3.0	3.1	3.4	28	3.3	2.8	1.8	2.5	1.7	3.0	3.1
13	3.4	2.8	2.0	1.2	2.9	3.1	4.1	29	3.2	2.7	1.3	2.0	1.7	3.0	3.1
14	3.3	2.7	3.0	1.2	2.9	3.1	4.7	30	3.0	2.8	1.0	1.8	1.7	3.0	3.1
15	3.3	2.6	3.0	1.3	2.9	3.0	3.3	31	.....	2.9	.9	.....	2.0	.....	3.1
16	3.3	2.5	2.9	1.4	2.9	3.0	3.2								

MILLVILLE STATION, ON THE SHENANDOAH RIVER.

This station is on the Shenandoah River, at Millville, W. Va., 4 miles above Harpers Ferry. The gage consists of a vertical board nailed to the projecting trunk of a tree and firmly fastened by cross braces. The bench mark consists of a notch cut in the tree opposite the 8-foot mark of the gage. The channel is rocky and not liable to change. Measurements are made from a small box, or car, 2 feet wide, 3.5 feet long, and 3 feet high, suspended from a $1\frac{1}{4}$-inch cable which has been erected by private parties for use of a ferry.

POINT OF ROCKS STATION, ON POTOMAC RIVER.

This station is at the toll bridge over the Potomac River near Point of Rocks, Md. It is equipped with a wire gage, which is read from the bridge floor, measurements of discharge being made from this bridge.

CHAIN BRIDGE STATION, ON POTOMAC RIVER.

Readings of river height at this point were begun on May 4, 1891, and continued until the end of 1893, when they were discontinued, owing to the difficulty of obtaining an observer. They were taken up again on December 18, 1894. The height of water is measured by means of a wire gage having a horizontal scale which reads from 10 to 30 feet. On March 20, 1895, this was supplemented by a cylindrical nilometer. Measurements of discharge are made from the bridge, but have not been wholly satisfactory, owing to the great velocity at times of high water. Computations of discharge of the river, based upon measurements at this point and upon a record kept at Great Falls, have been published in the Fourteenth Annual Report of this Survey, Part II, pages 135–137, giving the monthly flow from 1886 to 1893, inclusive.

LIST OF DISCHARGE MEASUREMENTS OF VARIOUS STREAMS IN THE UNITED STATES.

The following list gives, in brief, the results of individual stream measurements made at various stations established by this Survey, and at other points where it has been ascertained that such work has been carried on. For convenience of reference these are arranged in chronologic order. Many of them have been discussed more fully under the descriptions of the different river stations. In nearly all instances these measurements were made by means of current meters, by which the velocity of various portions of the current was ascertained, the meter being placed at regular intervals across the stream and near the surface, bottom, and in intermediate positions. The depth of the stream having been ascertained by sounding line or pole, and the width measured directly, the discharge for each portion was computed and the results were summed up as shown in the table. This list gives the

name of the stream, the locality or river station at which the measurements were made, and the name of the hydrographer or engineer under whose immediate direction the work was done. There is also given, wherever it can be obtained, an estimate of the drainage area in square miles above the point where these measurements were made. This estimate has in general been prepared by means of planimeter measurements of the best accessible maps, the outline of the drainage area being sketched according to the topographic features. Next to the right of this is given the height of water at the time of the measurement on the arbitrary gage established at the regular river stations; also the mean velocity, obtained by dividing the total computed discharge of the area by the cross section of the river at the point where the measurements were made. The discharge is given in units of cubic feet per second (now commonly employed), briefly designated, for convenience, second-feet.

List of discharge measurements of various streams in the United States.

Date.	Stream.	Locality.	Hydrographer.	Area drained.	Gage height.	Mean velocity.	Discharge.
1893.				*Sq. m.*	*Feet.*		*Sec feet.*
Jan. 14	Umatilla	Pendleton, Oreg	W.P.Trowbridge	640	1.54	.....	239
June 10	Shell Creek	Sheridan road, Wyo	E. Mead	.....	.....	.....	1
10	Clear Creek	Above Buffalo, Wyo	do	.....	.....	.....	304
12	do	do	do	.....	.....	.....	652
14	Piney Creek	Sheridan road, Wyo	do	.....	.....	.....	975
14	Fullerton Creek	do	do	.....	.....	.....	.....
14	Rock Creek	Road crossing, Wyo	do	.....	.....	.....	87
16	Clear Creek	Above Buffalo, Wyo	do	.....	.....	.....	178
22	do	do	do	.....	.....	4.494	134
July 6	Bear Gulch Creek	Above Kearney, Wyo	M. C. McFarlane	.....	.....	.....	2
17	Clear Creek	Above Buffalo, Wyo	E. Mead	.....	.....	2.32	37
18	Powder River	Old stage crossing	M. C. McFarlane	.....	.....	.....	66
24	Sundance Creek	Near Sundance, Wyo.	E. Mead	.....	.....	.....	1
26	Sand Creek	Near Beulah, Wyo	do	.....	.....	.....	55
Aug. 14	Yakima	Union Gap, Wash	F. H. Newell	.....	.90	3.09	2,963
14	Naches	North Yakima, Wash	do	.....	1.00	3.76	1,193
16	Katchess Lake	Outlet, Wash	do	.....	.....	2.58	211
22	West Gallatin	Above Salesville, Mont.	do	850	2.15	3.35	818
23	Madison	Near Red Bluff, Mont.	do	2,085	2.10	3.28	1,189
24	Jefferson	Three Forks, Mont	do	9,400	.....	1.83	808
24	Madison	do	do	2,285	.30	2.15	1,251
25	Missouri	Townsend, Mont	do	15,000	88.75	.....	3,008
Sept. 2	Bear	Collinston, Utah	do	6,000	1.70	1.40	715
10	St. Charles	Below Beulah, Colo	do	.....	.....	.....	4
22	Arkansas	Canyon, Colo	do	3,060	2.45	2.26	291
26	Yakima	Yakima, Wash	S. Storrow	.....	.25	.....	1,186
27	Arkansas	La Junta, Colo	F. H. Newell	12,200	.45	1.14	24
27	do	Holly, Colo	do	.....	.....	0	0
1894.							
Jan. 10	Tejon House Cr	Kern County, Cal	J. B. Lippincott	.....	.....	.....	60
21	do	do	do	.....	.....	.....	60
Mar. 4	do	do	do	.....	.....	.....	80
Apr. 24	Arkansas	Pueblo, Colo	P. J. Preston	4,600	.....	.....	332
May 8	North Platte	Orin Junction, Wyo	E. Mead	.....	.....	.....	6,823
15	Arkansas	Canyon, Colo	F. H. Newell	3,060	4.20	7.27	2,395
18	South side ditch	do	do	.....	.....	1.88	32
18	North side ditch	do	do	.....	.....	2.45	27
18	Arkansas	do	do	3.060	3.80	6.68	1,940
21	Little Laramie	So. Fork, Wyo	Luke Voorhees	.....	.....	3.57	69
21	Henry Canal	La Junta, Colo	F. H. Newell	.....	.....	3.08	620
21	Arkansas	do	do	12,200	1.20	1.57	157
21	Otero Canal	do	do	.....	.....	1.00	5
24	Potomac	Cumberland, Md	C. C. Babb	891	.....	.....	3,037
28	Rocky Ford ditch	Rocky Ford, Colo	F. H. Newell	.....	.....	2.22	71
28	Laguna ditch	do	do	.....	.....	2.83	187
28	Catlin ditch	do	do	.....	.....	2.41	104
28	Otero	do	do	.....	.....	1.70	136
28	High Line Canal	do	do	.....	.....	2.12	115
29	Vroomans	do	do	.....	.....	1.25	10

List of discharge measurements of various streams in the United States—Continued.

Date.	Stream.	Locality.	Hydrographer.	Area drained.	Gage height.	Mean velocity.	Discharge.
1894.				*Sq. m.*	*Feet.*		*Sec. feet.*
May 29	Rocky Ford ditch.	Rocky Ford, Colo	F. H. Newall....	.....	.....	2.68	110
29	Otero ditch	Apishapa flume, Colo.	.....do	.....	.....	1.66	141
29	Catlin ditch	Near head, Colo	.....do	.....	.....	2.76	290
29	Oxford ditch.....	.....do.....	.....do	.....	.....	4.83	174
29	High Line.....	.....do.....	.....do	.....	.....	2.87	365
31	Potomac.	Springfield, W. Va ...	R. H. Chapman.	1,443	4.70	2.02	1,074
June 1	Fosdicks ditch....	Near head, Colo	F. H. Newell....	.....	.....	2.06	70
1	Arkansas.....	Nepesta, Colo	.....do	.....	.....	4.00	12,000
2	.....do	.....do.....	.....do	.....	.....	3.90	8,000
6	Laramie River....	Uva bridge, Wyo	E. Mead.....	.....	.....	.....	1,845
7	Arkansas.....	La Junta, Colo	F. H. Newell....	12,200	7.80	3.33	15,000
7	North Platte.....	Orin Junction, Wyo..	E. Mead.....	.....	.....	.....	12,596
8	Arkansas.....	La Junta, Colo	F. H. Newell....	12,200	6.40	3.06	9,500
13	Rio Grande	Del Norte, Colo	.....do	1,400	2.68	.....	968
14	Little Goose Cr...	Sheridan Co., Wyo ...	M. C. McFarlane	.....	.....	.....	105
14	Wolf Creek.....	Canyon Bridge, Wyo.	.....do	.....	.....	.....	63
18	Arkansas.....	Canyon, Colo.....	F. H. Newell	3,060	4.80	.....	2,387
20	Big Goose Creek..	Sheridan, Wyo	M. C. McFarlane	.....	.....	.....	463
24	Tejon House Cr ..	Kern County, Cal	J. B. Lippincott.	.....	.....	.....	7
25	Shell Creek.....	Shell post-office, Wyo.	E. Mead	.....	.....	5.21	569
26	Big Horn.....	Lovell's Ferry, Wyo .	.....do	.....	.....	.....	26,010
July 2	Stinking Water...	Marquette's, Wyo....	.....do	.....	.....	.....	4,623
2	Potomac.....	Harpers Ferry, W. Va.	C. C. Babb	6,354	2,52	.....	1,223
6	Shenandoah	.....do.....	.....do	3,009	.....	.....	1,218
12	Gray Bull.....	Meeteetse, Wyo	E. Mead	.....	.....	.....	1,209
15	Wind.....	Merritts, Wyo	.....do	.....	.....	7.35	6,209
17	Big Popo Agie....	25 miles below Lander, Wyo.	M. C. McFarlane	.....	.....	.....	624
18	Little Popo Agie.	Below Youngs, Wyo .	.....do	.....	.....	.....	91
20	Big Sandy.....	Lander Cut-off trail ..	.....do	.....	.....	2.30	148
20	Weber.....	Uinta, Utah.....	S. Fortier.....	.....	1.10	2.84	396
21	New Fork.....	4 miles above forks ..	M. C. McFarlane	.....	.....	.....	2,055
21	Green	Above New Fork	.....do	.....	.....	.....	2,427
21	Potomac.....	Chain Bridge, D. C...	C. C. Babb	11,043	.....	.....	1,781
23	North Piney Cr ..	Uinta Co., Wyo	M. C. McFarlane	.....	.....	.....	285
23	Middle Piney.....	North Branch, Wyo ..	.....do	.....	.....	.....	255
23	Middle Piney.....	Uinta Co., Wyo	.....do	.....	.....	.....	93
23	Middle Piney.....	In canyon, Wyo.....	.....do	.....	.....	.....	140
26	North Platte.....	Camp Clarke, Nebr ..	O. V. P. Stout ...	.....	.....	.....	1,900
26	Pumpkin Seed Cr.	Cary's, Cheyenne Co .	.....do	.....	.....	.....	17
28	North Platte.....	Gering, Nebr.....	.....do	.....	.....	.....	2,450
30	Strawberry Creek.	In canyon, Wyo.....	M. C. McFarlane	.....	.....	6.85	195
31	Loup.....	Columbus, Nebr.....	O. V. P. Stout ...	.....	.....	.....	1,475
Aug. 4	Salt.....	In pass, Wyo.....	M. C. McFarlane	.....	.....	.....	628
4	Willow Creek.....	Near mouth, Wyo....	.....do	.....	.....	.....	104
7	Frenchman	Palisade, Nebr	O. V. P. Stout...	.....	.....	.....	94
7	Republican	Culbertson, Nebr.....	.....do	.....	.....	0	0
10	Swift Creek.....	Afton Bridge, Wyo...	M. C. McFarlane	.....	.....	.....	155
13	Stump Creek	Above Auburn, Wyo.	.....do	.....	.....	.....	67
14	Platte.....	Fremont, Nebr.....	O. V. P. Stout...	.....	.....	.....	1,420
15	Elkhorn	Waterloo, Nebr	.....do	.....	.....	.....	280
15	Weber.....	Uintah, Utah.....	S. Fortier.....	.....	.50	1.73	141
17	Crow Creek.....	At bridge, Wyo.....	M. C. McFarlane	.....	.....	.....	77
19	Loup.....	S. 13, T. 7 N., Wyo., R. 2 W.	L. F. Gottschalk	.....	.....	.....	1,335
20	Laramie	Near Laramie, Wyo ..	John Hunton...	.....	.....	1.38	51
21	Dry Creek.....	Near Afton, Wyo	M. C. McFarlane	.....	.....	.....	56
22	Dismal.....	Near Dunning, Nebr.	G. H. Lawrence.	.....	.....	.....	435
25	Middle Loup.....	Gates, Nebr.....	.....do	.....	.....	.....	850
25	Cottonwood Cr ...	So. of Aften, Wyo....	M. C. McFarlane	.....	.....	.....	79
	Platte	Fremont, Nebr.....	A. Rosewater...	.....	.....	.....	1,209
	Elkhorn	Arlington, Nebr.....	.....do	.....	.....	.....	214
Sept. 5	Tejon House Cr...	Kern County, Cal	J. B. Lippincott.	.....	.....	.....	1
10	South Loup.....	Georgetown, Nebr....	G. H. Lawrence.	.....	.....	.....	68
15	Cedar.....	Fullerton, Nebr.....	O. V. P. Stout...	.....	.....	.....	210
16	Loup.....	.....do.....	.....do	.....	.....	.....	1,704
17	Beaver Creek.....	Genoa, Nebr.....	.....do	.....	.....	.....	71
17	Platte.....	Columbus, Nebr.....	.....do	.....	.....	0	0
19	Weber.....	Pueblo, Colo.....	A. P. Davis.....	1,600	.35	.....	378
20	.....do	Canyon, Colo.....	.....do	1,600	.....	.....	395
20	South side ditch..	.....do.....	.....do	.....	.....	.....	33
20	North side ditch..	.....do.....	.....do	.....	.....	.....	22
23	Lake Creek.....	Twin Lakes, Colo....	.....do	102	.....	.....	43
24	Arkansas.....	Hayden, Colo.....	.....do	.....	1.20	.....	114
27	Rio Grande.....	Del Norte, Colo.....	.....do	1,400	1.52	.....	267
27	Laramie.....	Laramie, Wyo.....	W. M. Gilcrest..	.....	.....	.....	27
28	Rio Grande.....	Alamosa, Colo.....	A. P. Davis.....	.....	.....	1.01	11
28	Laramie	Wood's Landing, Wyo	W. M. Gilcrest..	.....	.....	.....	57
30	Rio Grande.....	Embudo, N. Mex.....	A. P. Davis.....	7,000	7.70	1.50	284

List of discharge measurements of various streams in the United States—Continued.

Date.	Stream.	Locality.	Hydrographer.	Area drained.	Gage height.	Mean velocity.	Discharge.
1894.				*Sq. m.*	*Feet.*		*Sec. feet.*
Oct. 1	Rio Grande	Embudo, N. Mex	A. P. Davis	7,000		3.25	1,138
3	North Platte	Uva Junction, Wyo.	F. H. Newell				
4	Mora	Watrous, N. Mex	A. P. Davis		1.68		35
5	North Platte	North Platte, Nebr.	Chas. P. Ross				620
5	Arkansas	La Junta, Colo	A. P. Davis	12,200	.40		55
6	Bear	Collinston, Utah	S. Fortier	6,600	2.01		1,800
6	Platte	Columbus, Nebr	O. V. P. Stout			0	0
7	Laramie	Near Fort Laramie	John Hunton			1.89	23
11	North Platte	Ogallala, Nebr	F. H. Newell				609
13	Arkansas	Pueblo, Colo	A. P. Davis	4,600	.39		370
15	do	Canyon, Colo	do	3,060	2.40		319
15	South side ditch	do	do				33
15	North side ditch	do	do				27
16	Arkansas	Hayden, Colo	do		1.24		91
17	Gunnison	Grand Junction, Colo.	do		1.25	.48	748
18	Grand	do	do		.60	1.10	1,585
21	Green	Blake, Utah	do		1.98	1.83	3,035
22	Pine	Helper, Utah	do		2.05		34
24	Humboldt	Golconda, Nev	L. H. Taylor		1.30	1.29	57
24	Provo	Provo, Utah	A. P. Davis	640	4.38		238
24	Laramie	Uva, Wyo	W. M. Gilcrest			2.06	14
26	North Platte	Orin Junction, Wyo.	do			1.42	502
27	Red River	Fargo, N. Dak	F. H. Newell				190
29	Bear	Battle Creek, Utah	A. P. Davis	4,500	1.90	2.12	980
30	St. Louis	Cloquet, Minn	F. H. Newell				6,067
Nov. 1	Snake	Blackfoot, Idaho	A. P. Davis	10,500		1.90	8,040
2	North Loup	Moulton, Nebr	G. H. Lawrence				460
3	Laramie	Wood's Landing	W. M. Gilcrest			1.47	80
4	Madison	Three Forks, Mont.	A. P. Davis	2,285	.57	1.99	1,494
6	North Platte	North Platte, Nebr.	Chas. P. Ross				1,960
7	do	Near Fort Laramie	John Hunton			2.23	630
13	Barton Spring	Austin, Tex	F. H. Newell				17
14	San Marcos	San Marcos, Tex	do				150
14	Jefferson	Sappington, Mont.	A. P. Davis	8,270	1.08	2.76	1,952
17	Gallatin	Logan, Mont	do		1.11	1.82	772
18	Missouri	Townsend, Mont	do	15,000	89.00	2.44	3,766
21	Naches	Nelson Bridge, Wash.	do		2.50	2.44	1,196
24	Toppenish	R. I. R. crossing, Wash.	do		3.40	2.4	49
24	Satas	North Branch, Wash.	do		2.00	3.00	27
25	Yakima	Union Gap, Wash	do			5.74	5,926
30	Bear	Battle Creek, Utah	S. Fortier	4,500	1.80		957
30	do	do	do	4,500	1.80		1,030
Dec. 4	Humboldt	Golconda, Nev	L. H. Taylor		2.00	1.31	114
6	Weiser	Weiser Canyon, Idaho	A. P. Davis	1,670	.90	1.10	277
7	Payette	Payette, Idaho	do		1.30	2.56	1,603
8	Frenchman	Palisade, Nebr	O. V. P. Stout		1.87	1.41	116
8	Owyhee	County bridge, Oreg.	A. P. Davis	9,875	1.40	1.47	307
9	Republican	Benkleman, Nebr	O. V. P. Stout		1.74	2.31	75
10	Malheur	Vale, Oreg	A. P. Davis	9,900	1.90	2.00	128
20	Sacramento	Red Bluff, Cal	do		10.70	8.60	*a* 45,000
22	Bear	Collinston, Utah	S. Fortier	6,000	1.80		957
24	Provo	Provo, Utah	do	640	4.40		390

a Approximate.

WELL RECORDS IN NEBRASKA, COLORADO, AND KANSAS.

The following well records were collected by Prof. Robert Hay in the course of his field work, while making a study of the water supply of a portion of the Great Plains. His conclusions are given in a paper accompanying the Sixteenth Annual Report of the Director, but it has not been practicable, for want of space, to give there the details concerning the different wells examined; and, on the other hand, these have been found to possess so many items of value that their publication seems desirable in order that they may be accessible to those particularly interested in the subject. These details are therefore published in this place.

The region examined by Professor Hay extends in a strip about 30 miles wide from the North Platte River along and near the one hundred and second meridian, this being at about the position of the eastern boundary of Colorado, and thus including portions of western Nebraska, eastern Colorado, and western Kansas. His reconnaissance extended as far south as the South Fork of Smoky Hill River, thus covering a strip of country about 170 miles in length. This area may be considered as typical of many thousand square miles of the Great Plains, and the conclusions drawn by Professor Hay have value to the inhabitants of a great part of the States named.

In the following list the wells have been arranged in alphabetical order by counties within each State in which they occur, and again in alphabetical order by post-offices within each county. The tabular statement embodies such facts as could be best expressed by one or two figures. The serial numbers in the first column of the table refer to details which could not well be expressed in tabular form, and which, for economy of space, have been placed after the table. Thus, to get the complete statement for any one well, reference should be made first to the table and then to the statement at the end of the table which has the same number.

The table gives first the arbitrary number; next, the post-office address of the owner of the well, this being presumably the nearest town; next, the name of the owner of the well, and to the right of this the location according to township, range, and section. All of the Land Office subdivisions in this part of the country are referred to the sixth principal meridian, this being understood in all cases. The townships are all north and the ranges west, the initials N. and W. at the top of the column expressing this fact. In the next column is given the year in which the well was completed, this indicating, presumably, the length of time during which the well has been used. The diameter of the well is, for uniformity, given in inches, the dug wells—those of 4 or 5 feet across—being noted as 48 or 60 inches in diameter. The adjacent columns give the total depth of the well in feet, this being the extreme distance from the surface of the ground to the bottom of the well. The depth of water is the height above the bottom at which the water usually stands. The cost of well usually includes all of the necessary expenses, except possibly the labor contributed by the owner himself in making preparations and in general oversight. Cost of machinery includes pump and suction pipe, windmill, or other device for raising the water.

Of the whole number of wells reported, Professor Hay states that 69 are used for irrigation, of which 22 are in Nebraska, 17 in Colorado, and 30 in Kansas. The number put to this use is being constantly increased, and the summer of 1895 will find them running up into the hundreds. This enumeration does not by any means include all of the wells in the district examined, but simply gives those visited by Professor Hay or

concerning which definite information was obtained. They may be regarded as typical, and the information concerning them so complete that the addition of facts relating to others would be of little value.

There is no longer doubt as to the feasibility of irrigating from 1 to 10 acres by water pumped from such wells, and the cost of so doing becomes a serious matter only when the wells approach or exceed 200 feet in depth. In this relation wells under 50 or 60 feet deep may be considered shallow wells, those up to 125 feet may be regarded as of moderate depth, and only those exceeding 180 feet need be considered as deep wells. The cost of well sinking and of pumping machinery is much less than it was when the earlier wells here enumerated were put down, and with improved methods and greater knowledge of conditions this is constantly decreasing, being least at the present time. The volume of underground water is best illustrated by considering the wells grouped together, as at the towns of Goodland, Cheyenne Wells, Sharon Springs, Kanorado, Haigler, St. Francis, Benkelman, Imperial, Lamar, Big Springs, Julesburg, Ogallala, Grant, etc. In general it may be said that the source of the water is from the local rainfall, a portion of this being absorbed by the previous strata, especially that designated in Professor Hay's paper as Tertiary grit. Artesian flows, or those in which the water rises and overflows the surface, have not been found; or at least not in sufficient quantity for the necessities of the plains; but, on the other hand, wells of the character of those here enumerated, especially those penetrating the Tertiary grit, hold a supply sufficiently great to bring under cultivation considerable areas, if suitable pumping machinery is employed. The intelligent, well-directed efforts of the settlers are being rewarded by success, and the results achieved within this area should serve as a stimulus to the undertaking of similar work in other parts of the country.

Data relating to wells in Nebraska.

CHASE COUNTY.

No.	Post-office.	Owner of well.	Location of well.			Year completed.	Diameter.	Depth of well.	Depth of water.	Cost of -	
			T.	R.	S.					Well.	Machinery.
			N.	*W.*			*In.*	*Feet.*	*Feet.*		
1	Champion ..	C. W. Armstrong.....	5	40	....	1888	36	64	6	$30.00	$35.00
2	.....do	G. W. Getzendaner....	6	39	32	1889	8	82	7	41.00	84.00
3	.....do	J. S. Bell.....	6	39	23	1889	10	31	10	16.00	75.00
4	.....do	Champion (precinct) ..	6	39	21	1894	3	217	.....	.....	.....
5	.....do	Jesse Long.....	5	41	8	1891	8	32	16	12.00	2.00
6	Dewitt	George Hunt.....	....	....	....	1888	12	70	7	.....	.....
7	Imperial....	H. H. Grosbach.....	6	38	4	1888	48	104	12	50.00	140.00
8	.....do	.....do.....	6	38	4	1890	6	112	24	50.00	100.00
9	.....do	Thomas Mercier	6	38	4	1890	12	123	36	50.00	175.00
10	.....do	James Burke.....	6	38	9	1886	18	100	4	35.00	123.00
11	.....do	B. and M. R. R. R.....	....	....	....	1892	4	137	8	.....	.....
12	.....do	C. E. Williams.....	7	40	9	1886	12	54	9	25.00	.....
13	Lamar.....	Mrs. G. Hasier.....	6	39	10	1893	8	101	11	25.00	75.00
14	.....do	Edward Bussel.....	6	40	18	1889	30	23	3	15.00	.....
15	.....do	John Morss.....	7	41	16	1889	8	65	7	.....	.....
16	.....do	Town well.....	7	41	16	1888	10	90	30	90.00	30.00
17	.....do	Public well.....	7	41	16	1888	42	65	5	65.00	30.00
18	.....do	Mr. May (tenant)	7	41	15	1890	42	60	6	30.00	35.00
19	.....do	Harry Wilson.....	7	41	31	1887	42	31	7	5.00	.....
20	.....do	Fremont Young.....	....	....	....	1888	42	26	7	5.00	110.00
21	.....do	A. E. McCall	8	41	35	1892	10	84	23	25.00	35.00
22	.....do	Frank Burney.....	7	41	23	1886	10	66	8	30.00	61.00
23	.....do	John Morss	7	41	29	1885	8	67	14	35.00	75.00
24	.....do	John Kingrick.....	7	41	28	1889	42	62	8	25.00	.....
25	.....do	E. P. Huffman.....	7	41	33	1887	48	18	4	5.00	5.00
26	.....do	J. H. Blanke	7	41	33	1893	8	30	9	5.00	5.00
27	.....do	J. W. Toothacre.....	6	41	21	1893	36	39	9	15.00	12.00
28	.....do	Miss A. C. Blake.....	6	41	20	1892	42	62	8	25.00	60.00
29	Venango....	W. E. Howell.....	....	....	....	1886	.....	108	6	100.00	.....
30	.....do	Hugh Rowley.....	8	41	15	1889	12	124	15	65.00	90.00
31	.....do	John Wietjes.....	8	41	10	1892	12	130	15	40.00	.....
32	.....do	W. Meyer.....	8	41	18	1891	8	132	16	50.00	72.00
33	.....do	.....	5	41	8	.....	.....	22	10	.....	.....

DEUEL COUNTY.

34	Big Spring..	Frank Dorn	13	41	30	1893	6	100	5	$100.00	$100.00
35	.....do	Alex. Morrison.....	....	....	....	1888	72	24	4	10.00	75.00
36	.....do	U. P. R. R	13	42	36	1891	144	14	7	.....	.....
37	.....do	Walter Kimball.....	12	42	2	1884	2½	15	8	.....	150.00
38	.....do	F. L. Miller.....	13	41	31	1894	3½	15	7	5.00	.....
39	.....do	J. E. Stenvall	14	42	32	1892	3½	236	19	236.00	80.00
40	.....do	E. A. Phelps.....	13	41	6	1887	7	205	6	160.00	125.00
41	.....do	W. H. Gilliard	14	42	20	1887	2	247	30	250.00	120.00
42	.....do	Ernest Johnson.....	13	42	18	1892	6	277	127	277.00	110.00
43	.....do	A. Zimmerman	13	43	24	1890	7	132	9	132.00	135.00
44	.....do	Mrs. M. E. Steward...	13	42	14	1893	8	153	.....	153.00	80.00
45	.....do	E. A. Phelps.....	13	41	30	1894	1½	18	3	5.00	55.00
46	Chappell ...	H D. Hostetter.....	13	44	20	1888	7	168	.....	.....	.....
47	Day	William Lador.....	15	42	34	1894	3½	304	9	350.00	60.00
48	.....do	A. D. Remington	14	42	13	1892	3½	330	100	165.00	335.00
49	.....do	G. C. Manser	14	42	24	1894	4½	274	24	250.00	150.00
50	Julesburg ..	W. F. Stafford	12	42	18	1890	4	20	8	5.00	100.00
51	.....do	Geo. Kalb.....	13	44	12	1893	5	225	21	.....	.....
52	.....do	Swan Johnson.....	13	44	14	1893	5½	218	21	145.00	110.00
53	.....do	Swan Friskopp	13	43	20	1893	7	180	.....	153.00	105.00
54	.....do	Thos. Bell	13	43	10	1893	6	197	20	197.00	120.00
55	.....do	S. Adams	15	42	36	1893	6	363	11	360.00	170.00

Data relating to wells in Nebraska—Continued.

DUNDY COUNTY.

No.	Post-office.	Owner of well.	Location of well.			Year completed.	Diameter.	Depth of well.	Depth of water.	Cost of—	
			T.	R.	S.					Well.	Machinery.
			N.	*W.*			*In.*	*Feet.*	*Feet.*		
56	Benkelman .	School district well...	....	....	....	1892	12	38	7	$16.00	$6.00
57	.....do	J. S. West	1	37	18	1893	12	112	13	40.00	85.00
58	.....do	Jos. Robidoux	....	....	....	1888	.....	41	15	.....	.....
59	.....do	.....do.....	....	....	....	1886	6	76	10	20.00	85.00
60	.....do	.....do.....	1	37	18	1888	1¼	25	17	.....	.....
61	.....do	David & Larimore.....	1	37	17	1885	2	24	12	25.00	60.00
62	Champion ..	J. U. Deselms.....	4	41	7	1893	12	37	22	25.00	90.00
63	Haigler.....	Frank Smith	1	40	23	1894	7	20	11	8.00	75.00
64	.....do	W. H. Sullivan.....	1	41	28	1894	42	50	26	15.00	85.00
65	.....do	Mr. Southlean	1	40	21	1885	42	10	4	.....	.....
66	.....do	W. R. Way.....	1	40	30	1885	12	45	13	25.00	.....
67	.....do	J. C. McPherson.....	....	....	....	1894	6	62	30	25.00	60.00
68	.....do	Town of Haigler.....	1	41	34	1888	6	62	32	20.00	65.00
69	.....do	H. R. Calkins.....	1	41	10	1889	.....	48	4	10.00	.....
70	Lamont.....	M. N. Palmer	....	....	....	1893	*a* 48	10	3	5.00	60.00
71	.....do	W. H. Griffiths	3	41	29	1893	48	42	27	10.00	87.00
72	.....do	R. F. Little.....	3	41	5	1894	42	18	2	10.00	.....

a Inches, square.

KEITH COUNTY.

73	Big Spring .	Henry Butz	14	41	22	1889	3	344	8	$296.00	$200.00
74	.....do	A. Sunderman	13	41	32	1894	2	292	60	190.00	110.00
75	.....do	E. E. Leech	13	41	22	1890	*a* 48	32	17	50.00	150.00
76	.....do	.....do.....	13	41	22	1894	.....	10	5	100.00	900.00
77	Brule.....	Jas. Scott	13	40	15	1892	.....	15	5	.....	.....
78	.....do	Ed. Cooney.....	....	....	....	1884	6	44	10	30.00	100.00
79	Day	Henry Brawz.....	14	40	18	1893	3	421	18	*b* 484.00	.....
80	.....do	M. S. Collins	15	41	10	1889	1½	22	5	.....	6.00
81	.....do	Thos. Clark	14	41	2	1892	2	402	35	500.00	120.00
82	Ogallala	F. P. Dickinson	15	39	36	1889	2	16	6	.....	7.50
83	.....do	A. Phelps	13	38	6	1885	8	16	3	15.00	6.00
84	.....do	U. P. R. R	13	38	6	.....	144	12	4	.....	.....
85	.....do	Jesse Campbell	13	39	7	1890	10	48	15	15.00	40.00
86	.....do	E. M. Searle.....	13	39	10	1886	1¼	30	6	.....	60.00
87	.....do	Jacob Nostrum.....	....	....	....	1886	3	190	10	220.00	9.00
88	.....do	J. H. Cameron.....	13	39	22	1889	12	47	6	10.00	75.00
89	.....do	John Felt.....	12	40	12	1892	2	225	10	196.00	66.00

b Well and machinery.

PERKINS COUNTY.

90	Big Spring..	G. W. Stocking.....	12	41	24	1887	*a* 48	.....	.....	$400.00	$100.00
91	Brandon....	D. Mohnssen.....	....	....	....	1885	2	195	5	.....	.....
92	.....do	J. C. Leonardson.....	....	....	....	1892	8	.....	.....	.....	.....
93	.....do	Town of Brandon.....	....	....	....	.....	.....	164	14	.....	.....
94	.....do	G. Whitford.....	....	....	....	1893	4	172	22	176.00	56.00
95	Brule.....	B. F. Woodall.....	12	40	19	.....	2	210	14	267.00	75.00
96	Grant	B. and M. R. R. R.....	10	39	13	1887	9	200	40	.....	.....
97	.....do	Jno. M. Mills.....	9	38	9	1886	12	138	24	140.00	300.00
98	Ogallala	Chas. Roesler.....	12	39	14	1887	2	214	32	300.00	120.00
99	Venango....	D. R Bivens.....	9	41	7	1892	10	185	15	.....	.....
100	.....do	Town of Venango.....	9	41	7	1888	8	190	40	120.00	125.00
101	.....do	J. C. Davidson.....	9	41	34	1891	7	154	27	63.00	40.00
102	.....do	Harvey Scott.....	....	....	....	1889	8	195	15	120.00	125.00
103	.....	.....	9	41	30	1886	4	160	18	.....	.....

a Inches, square.

No. 1.—Dug well; 336 gallons an hour; can be easily lowered, but the original level is restored in half an hour; water raised by wind pump with 10-foot wheel and 1.25-inch pipe; is used for domestic purposes, for 50 head of stock, and irrigated half an acre last year, to be increased to an acre this year. Strata passed through: Yellow sandy soil; magnesia at 5 feet; water in gravel and hard rock. The water level is about the same as that at Champion, in the valley of the Frenchman.

No. 2.—Drilled well; water level does not vary; can not be easily lowered; quality of water, hard; water raised by wind pump with 10-foot wheel and 1.25-inch pipe; is used for domestic purposes and 50 head of stock. Strata passed through: Soil, 3 feet; magnesia, the top sandy; hard ledge 20 feet down; water in gravel.

No. 3.—Bored well; does not vary; water rose about a foot in the well; about 20 barrels per hour; can not be easily lowered; quality of water, soft; water is raised by wind pump with 8-foot wheel and 1.25-inch pipe; is used for house and at times for 125 head of stock. Strata passed through: Soil, 5 feet; sand, 16 feet; water gravel, 10 feet.

No. 4.—Bored well. Strata passed through as follows:

	Feet.
Soil	4
Sand	8
Magnesia (water from 26 to 52 feet)	40
Gray rock and clay	60
Gravel with water	27
Red clay with hard streaks	20
Gravel, sand, and water	12
Clay	6
Sand, gravel, and water	38

No. 5.—Bored well. The second vein, at 30 feet, rose to the upper one, at 16 feet. The depth of water does not vary; can be easily lowered, but not exhausted; the quality of the water is not very hard; the water is raised by windlass; is used for domestic supply and for 9 head of stock. Strata passed through: Sand, magnesia (blue), 12 or 14 feet; quicksand with water; red magnesia, red clay, green magnesia, water in magnesia.

No. 6.—Bored well; can not be easily lowered; the quality of the water is hard; the water is raised by wind pump; is used for house and for many head of stock. The strata passed through are the same as in the other wells about Lamar.

No. 7.—Dug well. The quantity of water which can be obtained from the well has not been tested; can not be easily lowered; quality of the water, not very soft; water is raised by wind engine; is used for a livery barn. Strata passed through: Plains marl, not thick; magnesia with gravel at water. Temperature, 55° F.

No. 8.—Bored well; water does not vary; 5 gallons per minute; can not be easily lowered; quality of water, soft; water is raised by wind pump; is used for domestic purposes and for irrigating a garden. Strata passed through: Magnesia reached at 6 feet from surface; a red clay was passed through in the magnesia and gravel below. This well is about 1,100 feet from No. 1, and has the same temperature.

No. 9.—Drilled well, dug part of the way; water rose a few feet at first; 600 gallons per hour; can not be lowered; water raised by wind pump with 12-foot wheel; is used for domestic purposes and for subirrigation of 4 acres. Strata passed through: Magnesia reached 7 feet from surface; a hard ledge passed through above the water, which is in gravel. This well is 2,000 feet from No. 8, and farther from No. 7.

No. 10.—Dug and drilled well; flow slightly decreased by being partly filled; 240 gallons per hour; can be lowered slightly; quality of water, hard; water raised by wind pump with 12-foot wheel. The water is used for domestic purposes, for 25 head of stock, and irrigates nearly a quarter of an acre. Strata passed through: Magnesia reached at about 20 feet; water was in coarse gravel. This well is nearly as far from No. 7 as No. 9, but in the opposite direction.

No. 11.—Drilled well; 45,000 gallons in 18 hours; can not be lowered; quality of water, hard; water raised by steam pump. Strata passed through: Struck magnesia at 16 feet; a vein of water was reached at 100 feet, which is shut off; hard rock below that to the water used. This well is between wells Nos. 8 and 10.

No. 12.—Bored well; 7 barrels per hour; can not be easily lowered; water raised by buckets and windlass; is used for domestic purposes and for 25 head of stock. Strata passed through: Yellow subsoil, 4 feet; magnesia; water in 9 feet of gravel and sticky rock at bottom; had not reached second sheet.

No. 13.—Drilled well; water rose a few feet in the well; can not be lowered; water raised by wind pump with 8-foot wheel and 1.25-inch pipe; is used for domestic purposes and for 20 head of stock. Strata passed through: Soil, 10 feet; then magnesia; 6 inches of hard rock above the water, which is in gravel. Temperature, 55.5° F.

No. 14.—Dug well; varies with the height of the neighboring mill pond; can be easily lowered; quality of water, medium hard; water raised by means of rope and buckets. Strata passed through: All in the magnesia. This well, with Nos. 3 and 4, is in the valley of the Frenchman.

No. 15.—Dug and bored well; can be easily lowered; quality of water, medium hard; temperature, 52° F.; water raised by hand pump; is used for a livery barn. Strata passed through: Magnesia reached at 6 feet; water is in gravel. This well is in the town of Lamar. Four other wells near by do not influence one another.

No. 16.—Bored well; can be easily lowered; water raised by hand pump; is used for domestic purposes and for stock. This is the public town well. Strata passed through: Soil, 5 feet; hardpan, 8 feet; magnesia, 2 feet; sandy gravel, 45 feet; gravel and sand, 30 feet, with water. This well is 350 feet south from No. 15, and the same distance north from No. 17.

No. 17.—Dug well; quality of water, not very hard; water used constantly by the public. Strata passed through: Magnesia at surface, 5 feet; sand and gravel, 60 feet.

No. 18.—Dug well; can not be easily lowered; quality of water, rather hard; water raised by hand force pump; is used for house and for 50 to 60 head of stock. Strata passed through: Soil, sandy loam, 5 feet; sand and hardpan, 13 feet; magnesia, 3 feet; sand and gravel, 39 feet. The hardpan here described is a dark-lavender clay, containing fine sand, but impervious to water.

No. 19.—Dug well; can not be easily lowered; water raised by means of pulley and buckets; is used for domestic purposes and for stock. Strata passed through: Loamy soil, 5 feet; cohesive sand, 26 feet; no magnesia. This well is south of the Frenchman, approaching the sand hills. The water was struck suddenly.

No. 20.—Dug well; can not be easily lowered; water raised by wind pump; has been used for supplying from 300 to 600 head of cattle ever since made. Strata passed through: Loam and sand.

No. 21.—Bored well; water rose 1 foot; depth of water does not vary; can not be easily lowered; quality of water, medium soft; water raised by wind pump with 10-foot wheel; is used for domestic supply and for 30 head of cattle. Strata passed through: Soil, 1 foot; magnesia, 1 foot; red clay; sand with water.

No. 22.—Bored well; depth of water does not vary; 24,000 gallons per day; can not be easily lowered; quality of water, rather hard; water raised by wind pump with 12-foot wheel; is used for domestic supply, for 10 head of stock, and for irrigating one-third of an acre. Tank, 40 by 20 by 1 feet. Strata passed through: Soil, 2.5 feet; magnesia; dry gravel, magnesia; gravel with water. In a well southeast of same section water was struck at from 60 to 82 feet.

No. 23.—Bored well. The water was found at the bottom, and it rose 14 feet. Depth of water does not vary; can not be easily lowered; quality of water, not very hard; water raised by wind pump with 10-foot wheel; is used for domestic supply and for 60 head of stock. Strata passed through: Soil, 1 foot; magnesia; rock (at 50 feet); gravel and sand.

No. 24.—Dug well; depth of water does not vary; can not be easily lowered; quality of water, medium soft; water raised by wind pump with 12-foot wheel; is used for domestic supply, for 10 head of stock, and for irrigating 1 acre. Strata passed through: Soil, magnesia, gravel. A well 1 mile east has about the same depth and similar conditions.

No. 25.—Dug well; rises with the Frenchman River, which is within 50 feet; can be easily lowered by the pump; water raised by hand pump; is used for domestic supply and for 50 head of stock. Strata passed through: Black muck and gravel at bottom. This well is on the Frenchman bottom, the river at this point being only a few rods wide, though somewhat wider above.

No. 26.—Bored well; can be easily lowered by rapid pumping; quality of water, medium soft; water raised by hand pump; is used for domestic supply. Strata passed through: Gravel. There are magnesia bluffs close to, but the formations are variable here. This well is 1¼ miles east by south from No. 25. A short distance south (across the Frenchman) is a schoolhouse well, 54 feet deep, on the magnesia bluffs. The pools in the river bed here are the first permanent water of the Frenchman. (See Follett's sections, Fifty-second Congress, first session, Senate Ex. Doc. 41.)

No. 27.—Dug well; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by hand pump; is used for domestic supply and for 14 head of stock. Strata passed through: Soil, a few inches; sandy loam, 4 feet; magnesia. Water in a sandy formation. There was a little seep of water at 16 feet. This well is on the north edge of the sand hills.

No. 28.—Dug well; depth of water does not vary; can be emptied in two hours, but is replenished to a depth of 3 feet in an hour; quality of water, not very soft; water raised by wind pump with 12-foot wheel; is used for domestic supply, for 55 head of stock, and irrigates a small area. Strata passed through: Soil and sand, 20 feet; magnesia to near the water; hard just above the water; water in greenish magnesia. Wells in the neighboring quarter section have water at about the same level and similar conditions. This well is in the sand hills.

No. 29.—Well originally dug, now tubed. The depth of the water does not vary, though, having caved in, the water is not as abundant as formerly. Can not be easily lowered; quality of water, soft; water raised by windlass; is used for domestic supply and for 10 head of stock. Strata passed through: Gravel and sand, with a little rock near the bottom. A well 1 mile south is 98 feet deep.

No. 30.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, rather soft; water raised by wind pump; is used for domestic supply and for 40 head of stock. Strata passed through: Soil, 2 feet; magnesia; rock and gravel. There is some plains marl soil in the neighborhood.

No. 31.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, rather soft; water raised by hand buckets and horse; is used for domestic supply and for 16 head of stock. Strata passed through: Soil, 3 feet; sandy clay; rock to bottom. The magnesia shows 10 rods away, but is not in the well. A well on the southwest quarter of this section has a wind mill, and the water is abundant at the same depth.

No. 32.—Bored well; depth of water does not vary; 7½ barrels per hour; can not be easily lowered; quality of water, rather soft; water raised by wind pump; is used for domestic supply and for 50 head of stock. Strata passed through: Soil, 3 feet; sand, light with magnesia (plains marl?), 40 feet; gravel, 73 feet; rock, 4 feet; gravel with water to bottom.

No. 33.—Dug well; depth of water does not vary; 22 barrels per hour; water raised by wind pump with 8-foot wheel. Strata passed through: This only reached first vein of water in quicksand, as at No. 5, which is in the same quarter section. A well 8½ miles northeast towards Champion is 50 feet deep.

No. 34.—Drilled well; depth of water does not vary; can be exhausted by pumping in 24 hours, but the water level is restored in a few hours; quality of water, not

very hard; water raised by wind pump with 14-foot wheel; is used for domestic supply and for a little irrigation. Strata passed through: Soil, 3 feet; magnesia; rock; gravel.

No. 35.—Dug well; depth of water does not vary; can not be lowered by the pump running all day; quality of water, soft; water raised by wind pump with 12-foot wheel and 4-inch cylinder; is used for domestic supply and for 600 head of cattle. Strata passed through: Magnesia and gravel.

No. 36.—Dug well; depth of water does not vary; pumping 500 gallons per minute can not lower it; quality of water, soft; water raised by wind pump with 26-foot wheel; is used for railway purposes. Strata passed through: River alluvia. The water is partly supplied by the overflow seepage from the "Big Spring," which is about 30 rods north and 20 feet higher.

No. 37.—Dug four feet, driven well below; depth of water does not vary; can not be easily lowered; quality of water, hard; water raised by wind pump, geared with 12-foot wheel; is used for domestic supply, for 150 head of stock, and for irrigating half an acre. Strata passed through: River alluvia. The June freshet—the so-called "Coxey flood"—wet by percolation all the hay land between this well and the river, which is to the north of it about 100 rods.

No. 38.—Driven well; depth of water does not vary; can not be easily lowered; quality of water, rather hard and alkaline; water raised by hand pump; is used for domestic supply and for 25 head of stock. Strata: River alluvia; clay at bottom. This is the South Platte bottom, on the south side of the river.

No. 39.—Drilled well; water rose 9 feet above where it was first struck; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 30 head of stock. Strata: Soil, 2 or 3 feet; magnesia; sand and gravel.

No. 40.—Drilled well; depth of water does not vary; can not be easily lowered; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 10 to 15 head of stock. Strata passed through: Soil, 3 feet; yellow clay, 10 feet; gravel to bottom This is well No. 3 of Mr. Follett's Big Spring line. (Fifty-first Congress, first session, Senate Ex. Doc. 41, Appendix V.)

No. 41.—Drilled well; depth of water does not vary; can not be easily lowered; quality of water, rather hard; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 200 head of stock. Strata: As usual on the plateau.

No. 42.—Drilled well; water was reached at bottom of well, but rose to 127 feet; depth of water does not vary; half tank (10 feet by 20 feet) in half a day; can be lowered with one-half day's pumping, but is restored in a few hours; water raised by wind pump with 12-foot wheel; is used for domestic supply and for stock. Strata passed through: One foot of soil, limestone, and some clay; water in gravel.

No. 43.—Drilled well; depth of water does not vary; sometimes there is 13 feet of water, but the depth never falls below 9 feet; 975 gallons in 2 hours' pumping; water raised by wind pump with 12-foot wheel; is used for domestic supply, for 50 head of stock, and for irrigating one-quarter of an acre. Tank, 30 feet in diameter. Strata passed through: Soil, 8 feet; magnesia, 2 or 3 feet; sand and gravel, 10 feet; cement gravel, about 20 feet; yellow clay, 11 feet; sand and gravel to water, and a lime rock in the water.

No. 44.—Drilled well; water rose a little when first struck; depth of water does not vary; can not be easily lowered; quality of water, hard; water raised by wind pump; is used for domestic supply and for over 50 head of stock. Strata passed through: Soil, 2 or 3 feet; magnesia, 4 or 5 feet; gravel all the way to water, with red sand.

No. 45.—Driven well; depth of water does not vary; can not be easily lowered; quality of water, hard; water raised by wind pump; is used for a hotel and for domestic supply. Strata passed through: Gravel, black soil, 2 feet; magnesia and gravel.

No. 46.—Drilled well; depth of water does not vary; can not be easily lowered; quality of water, hard; water raised by wind pump with 12-foot wheel; is used for domestic supply. Strata passed through: As usual in this district. The magnesia outcrops a mile north at the surface.

No. 47.—Drilled well; depth of water does not vary; can not be easily lowered; quality of water, medium hard; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 25 head of stock. Strata passed through: Soil, 3 feet, yellow clay, 39 feet; gravel, 25 feet; hard rock, 50 feet; gravel, 15 feet; a little magnesia and gravel to water. This well is also on a plateau, near the top of the bluffs overlooking the North Platte.

No. 48.—Drilled well; depth of water does not vary; 200 barrels per day; can not be easily lowered; water raised by wind pump with 14-foot wheel; is used for domestic supply and for 200 head of stock. Temperature, 54° F. Strata passed through: Soil, 8 feet; yellowish clay, 88 feet; sand and gravel with water; clay, magnesia, and gravel; a little rock; magnesia at 300 feet. There was also a sheet of water at 90 feet.

No. 49.—Drilled well; water rose about 18 feet; depth of water does not vary; 200 gallons per hour; can not be easily lowered; quality of water, rather soft; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 100 head of stock. Strata passed through: Soil, 3 feet; yellow clay, 20 feet; sand and clay, 35 feet (these are the plains marls); magnesia, gravel, and sand to bottom. Drill went 80 feet below the water in reddish, soft magnesia, but struck no more water.

No. 50.—Dug and driven well; water rose slightly; depth of water varies with the height of the river to the extent of 2 or 3 feet; can not be easily lowered; quality of water, rather soft; water raised by wind pump with 12-foot wheel; is used for domestic supply. This well, with three others, waters between 100 and 200 head of stock and irrigates 7 or 8 acres, all of them discharging into a tank three-quarters of an acre in area. Strata passed through: Soil; sand; clay, 2 feet above the water. Temperature, 52° F.

No. 51.—Drilled well; water rose 13 feet when struck; depth of water does not vary; can not be easily lowered; quality of water, rather soft; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 20 head of stock. Strata passed through: As usual on this plateau.

No. 52.—Drilled well; water rose 13 feet; depth of water does not vary; can not be easily lowered; quality of water, not very hard; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 50 head of stock.

No. 53.—Drilled well; depth of water does not vary; can not be easily lowered; quality of water not very hard; water raised by wind pump; is used for domestic supply and for stock. Much sand caved in while drilling.

No. 54.—Drilled well; depth of water does not vary; can not be easily lowered; quality of water hard; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 45 head of stock all summer. Strata passed through: Mostly gravel.

No. 55.—Drilled well; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump; is used for domestic supply and for 3,000 head of sheep. Strata: Soil, 11 feet; sand and magnesia.

No. 56.—Bored well; can not be easily lowered; quality of water, soft; water raised by hand pump; is used for a schoolhouse. Strata passed through: Soil, 1 foot; sand, or sandy soil, 30 feet; quicksand and pebbles, 8 feet; blue shale at bottom.

No. 57.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, medium hard; water raised by wind pump with 8-foot wheel; is used for domestic supply and for irrigating a number of trees. Strata passed through: Soil, 1 foot; sand all the way down. This is 75 feet above the railway on

the bottom, being in the highest part of the town. It appears that the sand-hill region has here encroached upon the river bottom.

No. 58.—Dug 26 feet, drilled 15 feet; depth of water does not vary; 4 barrels per hour can not be easily lowered; quality of water, medium hard; water raised by wind pump with 8-foot wheel; is used for domestic supply and for 5 head of stock. Strata passed through: Sand; gravel; sand. This well is in the town. There are about 50 wells in the town of Benkelman.

No. 59.—Bored well; depth of water does not vary; water can be obtained from the well for whole days and nights in succession; can not be easily lowered; quality of water, medium soft; water raised by wind pump with 8-foot wheel; is used for domestic supply and for irrigating a garden and an orchard. There is no record of the strata. The well is in the town, but on the slope above the bottom.

No. 60.—Driven well; depth of water does not vary; can not be easily lowered; quality of water, hard; water raised by hand pump; is used for the customers of a large general store. River alluvia (sand).

No. 61.—Driven well; depth of water does not vary; can not be easily lowered; quality of water, not very hard; water raised by wind pump with 10-foot wheel; is used for livery barn and for 400 head of stock. Strata passed through: Probably all river alluvia, being in the lower part of the town, on Republican bottom. There are several wells near at this level, but none farther out on the bottom.

No. 62.—Bored well; first water was struck at 15 feet, and rose 1 foot; depth of water does not vary; can not be easily lowered; quality of water, medium soft; water raised by wind pump with 10-foot wheel; is used for domestic supply and for 480 head of cattle; tank kept full all the time. Strata passed through: Sand, 16 feet; quicksand, 8 feet; magnesia, 13 feet.

No. 63.—Bored well; depth of water does not vary; 16 gallons per minute; can not be easily lowered; quality of water, rather soft; water raised by wind pump with 8-foot geared wheel; is used for 80 head of stock and for irrigating half an acre. Strata passed through: Soil and sand, 9 feet; coarse gravel, 11 feet. There are several wells on the river bottom of similar depth and material, confined to a strip of the North Fork Republican Valley one-half mile wide. A similar strip on each side of the valley slope has wells about 60 feet deep, as at Haigler.

No. 64.—Dug and drilled well; depth of water does not vary; can not be easily lowered; quality of water, hard and alkaline; water raised by wind pump with 9-foot wheel; is used for domestic supply, for 10 head of stock, and for irrigating a small area. Strata: Soil; yellow sandy loam; clay and gravel.

No. 65.—Dug well; depth of water does not vary; water raised by means of rope and buckets; is used for domestic supply. Strata passed through: Soil; sand and clay; gravel with water. This well is on Republican bottom.

No. 66.—Bored well; depth of water does not vary; can be easily lowered at times, owing to a defect in tubing; quality of water, medium soft; water raised by means of pulley and buckets; is used for domestic supply and for 15 head of stock. Strata passed through: Soil, 3 feet; yellow clay, with streak of sand in middle, 29 feet; coarse sand, with water, to bottom. This well is on the second slope of the North Fork Republican, 3 miles east of Haigler.

No. 67.—Drilled well; depth of water does not vary; 10,000 gallons per day; can not be easily lowered; quality of water, hard; water raised by wind pump with 10-foot wheel; is used for domestic supply, and has irrigated one-eighth of an acre. Strata passed through: Soil, 1½ feet; yellow clay, 30 feet; sticky yellow clay, with water, 20 feet; quicksand, 3 feet; sandy clay, 7 feet. A well three blocks west is 78 feet deep. After passing through the same formations, gravel was reached at 75 feet, water being struck at the same level as in No. 67, the well referred to having 48 feet of water.

No. 68.—Dug and bored well; depth of water does not vary; can not be easily lowered. There are two sheets of water, the upper being hard and the lower

soft. Water raised by wind pump with 12-foot wheel; is used for public purposes, including irrigation of trees on both sides of a street. Strata passed through: Yellow clay, 32 feet; sticky yellow clay, with water, 20 feet; fine quicksand, 3 feet; sandy soil, 7 feet. There are 4 wells in the town of Haigler, all of which are used for irrigating small areas.

No. 69.—Dug well; depth of water does not vary; can not be easily lowered; water raised by means of pulley and buckets; is used for domestic supply and for 30 head of stock. Strata passed through: Sand; magnesia, coarse sand, and gravel with water.

No. 70.—Dug well; depth of water does not vary. During October, 1894, however, which was extremely dry, the depth of the water seemed to decrease. It is apparently increasing at the present time; can not be easily lowered; quality of water, soft; water raised by wind pump with 10-foot wheel; is used for domestic supply and for 200 head of stock. Strata passed through: Magnesia; soil; quicksand.

No. 71.—Dug and driven well; depth of water does not vary; 300 barrels in one day; can be lowered slightly, and then keeps its level; quality of water, soft; water raised by wind pump with 8-foot wheel; is used for domestic supply and for 400 head of stock. Strata passed through: Sand, 10 feet; magnesia and rock; yellow clay and gravel.

No. 72.—Dug well; depth of water varies about a foot from dry years to wet; can not be easily lowered; quality of water, not very hard; water raised by means of pulley and buckets; is used for domestic supply and for 30 head of stock. Strata passed through: All sand.

No. 73.—Drilled well; depth of water does not vary; 200 gallons per hour; can not be easily lowered; quality of water, not very hard; water raised by wind pump with 14-foot wheel; is used for domestic supply and for 75 head of stock. Strata passed through: Soil, 5 feet; yellow clay, 90 feet; magnesia, red clay, and gravel to bottom; no hard rock.

No. 74.—Drilled well; depth of water does not vary; can not be easily lowered; quality of water, medium hard; water raised by wind pump with 14-foot wheel; is used for domestic supply and for 150 head of stock. Strata passed through: Soil with gravel, 3 feet; yellow clay, 40 feet; gravel; rock and gravel to bottom.

No. 75.—Dug well. There are two sheets of water, the lower sheet rising to the upper one. The depth of the water does not vary, except that it rises to the extent of 18 inches when the river, which is 60 rods distant, is at flood; 65 gallons per minute; can not be easily lowered; water raised by wind pump with 14-foot wheel; is used for domestic supply, for 150 head of stock, and for irrigating 1 acre. Strata passed through: Soil, 2½ feet; fine quicksand and magnesia, 12½ feet; quicksand with water, 6 inches; coarse gravel, 1½ feet; clay, 8½ feet; and gravel to the water, which is in quicksand at bottom.

No. 76.—Dug well; depth of water varies with the height of the river; 6 cubic feet per second; quality of water, hard; water raised by steam centrifugal pump; is used for irrigation. Strata passed through: River alluvia, with a bed of clay at the bottom, which is 8 feet thick. This is a trench, rather than a well, and was not completed at the time of the writer's visit. The remarkable manner in which this trench was affected by the "Coxey" flood is given in the paper in the Sixteenth Annual Report of the United States Geological Survey.

No. 77.—Driven well; depth of the water varies with the height of the river; can not be easily lowered; water raised by steam pump; is used for domestic supply and for a small number of cattle. Strata passed through: River alluvia. This well is on the South Platte bottom, and there are a number of wells about the village of Brule with plenty of water.

No. 78.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, rather hard; water raised by wind pump; is used for domestic

supply, for 140 head of stock, and is capable of watering 500 head. Strata passed through: Sand and gravel. This well is three-quarters of a mile from the river and was not affected by the June freshet.

No. 79.—Drilled well. This is not a successful well because of the sand drawing in and hindering the supply of water. Water raised by wind pump with 14-foot wheel. Strata passed through: Soil, 4 feet; yellow clay (the plains marl), and the usual magnesia and gravel of this plateau. The marl is about 100 feet.

No. 80.—Driven well; depth of water varies with the height of the river, which is 40 rods distant; water can be obtained from the well all day and night; can not be easily lowered; quality of water, hard; water raised by hand pump; is used for domestic supply. Strata passed through: River alluvia.

No. 81.—Drilled well. Broken casing and bad workmanship have rendered this well useless. Depth of water does not vary; could not be easily lowered; quality of water, medium hard; water raised by wind pump with 14-foot wheel. Strata passed through: Soil, 4 feet; yellow, limy, or gray, soil (the marl), 120 feet; white magnesia, yellow magnesia, gravel, and coarse sand with the water. This well is within 40 rods of the top of the plains marl bluffs, whose precipitous fronts begin the descent to the North Platte, the bed of which is over 500 feet below.

No. 82.—Driven well; depth of water does not vary; can not be easily lowered; quality of water, medium hard; water raised by hand pump; is used for domestic supply and for 25 head of cattle. Strata passed through: River alluvia. This well is on the North Platte bottom.

No. 83.—Bored well; depth of water does not vary; 10 gallons per minute; can be lowered by rapid pumping; quality of water, hard; water raised by hand pump with 3-inch cylinder; is used for domestic supply, and has irrigated a city block 250 feet square. Strata passed through: River alluvia. This well seems to have been affected by the freshet in the river last June, as the water is raised with less difficulty than formerly.

No. 84.—Dug well; slightly lowers with pumping, and varies with the water in the South Platte, from which it is distant between 60 and 70 rods; 6,000 gallons per hour for 6 hours can be obtained from the well, this filling the tank, and at the same time lowering the well; quality of water, not very hard; slightly alkaline; water raised by steam pump; is used for railway purposes. Strata passed through: Sandy alluvia.

No. 85.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump with 10-foot wheel; is used for domestic supply and for 50 head of stock. Strata passed through: Soil, 2 feet; fine yellow sand (plains marl), 18 feet; water in gravel. This well is on the second slope to the river, which is three-quarters of a mile to the north.

No. 86.—Driven well; depth of water does not vary; can not be easily lowered; quality of water, not very hard; water raised by wind pump; water used for domestic supply and for 200 head of stock. Strata passed through: River alluvia. This well is near the river. A water hole one-quarter of a mile north of the well had water by percolation after the June freshet.

No. 87.—Drilled well; depth of water does not vary; can not be easily lowered; quality of water, not very hard; water raised by wind pump with 12-foot wheel; is used for domestic supply and for stock. Strata passed through: Soil, 3 feet; sand; magnesia; gravel rock, 2 feet; gravel with water.

No. 88.—Bored well; depth of water does not vary; 75 to 100 barrels per day; can not be easily lowered; quality of water, rather soft; water raised by wind pump with 10-foot wheel; is used for domestic supply, for 50 head of stock, and for irrigating 1½ acres. Strata passed through: Soil, 3 feet; fine magnesia sand (plains marl?), 5 feet; clay and sand, 4 feet; gravel and sand, 35 feet.

No. 89.—Tubular well; depth of water does not vary; 20 barrels in 4 hours; can not be easily lowered; quality of water, soft; water raised by wind pump with

10-foot wheel; is used for domestic supply, for 60 head of stock, and for irrigating about one-half an acre. Strata passed through: Soil, 1½ feet; reddish yellow clay, 1½ feet; magnesia, sand, and gravel to water.

No. 90.—Dug well; depth of water does not vary; 1 barrel in 15 minutes; can not be easily lowered; quality of water, not very hard; is used for domestic supply and for 60 head of stock. Strata passed through: Soil, 2 feet; magnesia; water in sand.

No. 91.—Bored well; depth of water does not vary; 30 barrels per day; can not be easily lowered; quality of water, not very hard; water raised by wind pump.

No. 92.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, not very hard; water raised by wind pump; is used for domestic supply, for 15 head of stock, and for irrigating a small garden. Strata passed through: Magnesia near top, and water in gravel.

No. 93.—Bored well; depth of water does not vary; can not be easily lowered; water raised by wind pump; is used for domestic supply and for the stock of all the district.

No. 94.—Bored well; depth of water does not vary; 20 barrels per day; can not be easily lowered; water raised by wind pump; is used for domestic supply and for 20 head of stock. Strata passed through: Soil, 14 feet; sand and gravel to water; some hard streaks and some claylike soapstone.

No. 95.—Drilled well; depth of water does not vary; 1 barrel in 25 minutes; can not be easily lowered; quality of water, soft; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 25 head of stock. Strata passed through: Soil, 2 feet; light-yellow clay, 80 feet; gravel, magnesia, and gravel to water.

No. 96.—Dug 160 feet; drilled 40 feet more; rose slightly when water was struck; steam pump exhausts the well every day, but it is speedily replenished; depth of water does not vary; 36,000 gallons per day; can be easily lowered; quality of water, not very hard; water raised by steam pump; is used for railway purposes and for supplying the town of Grant. Strata passed through: Soil, 18 inches; magnesia, gravel, and sand, with cemented gravel 6 inches above the water.

No. 97.—Dug 110 feet; bored 28 feet. This well flowed at the surface 10 barrels in 1887, again a month later, and again six months afterwards; depth of water does not vary; with the mill running constantly, the water can not be easily lowered; quality of water, rather harder than when the well was first dug; water raised by wind pump; is used for domestic supply and for 50 head of stock. Strata passed through: Soil, 18 inches; sand, 2 feet; joint clay, 2 feet; magnesia, 2 feet; gravel, 22 feet; magnesia rock, 5 feet; red clay, 6 feet; gravel, 6 feet; red clay, 8 feet; gravel to water, with some hard rock.

No. 98.—Dug 184 feet; drilled 30 feet; depth of water does not vary; can not be easily lowered; quality of water, not very hard; water raised by wind pump with 14-foot wheel; is used for domestic supply and for 40 head of stock. Strata passed through: Sand most of the depth.

No. 99.—Bored well; depth of water does not vary; water obtained from the well day and night; can not be easily lowered; quality of water, soft; water raised by wind pump; is used for domestic supply, for livery barn, and for neighborhood stock. Strata passed through: Soil, a few feet; a little white magnesia; water in hard magnesia.

No. 100.—Bored well; water rose a little when first struck; depth of water does not vary at different times of the year; can not be easily lowered; quality of water, hard; water raised by wind pump; is used by the public. Strata passed through: Soil, 4 feet; magnesia, 10 feet; red-clay soil, 30 feet; hard-rock shale (clay?); gravel with water.

No. 101.—Bored well; has risen 13 feet; can not be easily lowered; quality of water, not very soft; water raised by wind pump; is used for domestic supply and

for 100 head of stock daily. Strata passed through: Soil, 20 feet; clay and gravel; streaks of black or brown dirt; no magnesia; water in gravel.

No. 102.—Depth of water does not vary; can not be easily lowered; quality of water, hard; water raised by wind pump; is used for domestic supply and for stock. Strata passed through: Same as in Venango well.

No. 103.—Drilled well; depth of water does not vary; can not be easily lowered; quality of water soft; water raised by wind pump. Strata passed through: Soil, 1 foot; magnesia, a few feet; gravel.

Data relating to wells in Colorado.

ARAPAHOE COUNTY.

No.	Post-office.	Owner of well.	Location of well.			Year completed.	Diameter.	Depth of well.	Depth of water.	Cost of—	
			T.	R.	S.					Well.	Machinery
			S.	*W.*			*In.*	*Feet.*	*Feet.*		
1	Idalia	E. M. Thurber	4	44	16	1888	7	206	12	$115.00	$120.00
2	do	H. H. Fisher	4	44	22	1887	36	194	2	110.00	110.00
3	do	J. S. McClellan	4	44	1	.....	.....	203	7	.....	.....
4	do	J. H. Cupp	3	44	26	1892	6	235	14	85.00	95.00
5	do	Jno. Gerber	3	44	33	1892	5	225	10	90.00	105.00
6	Jaqua, Kans	Geo. Hadley	5	42	10	1880	.....	18	8	.....	.....
7	Lansing	C. C. Kirkland	4	44	6	1892	6	189	16	72.00	125.00
8	do	F. A. Greatsinger	3	43	35	1891	6	224	4	100.00	140.00
9	do	C. J. Shoemaker	3	42	34	1893	6	213	8	85.00	105.00
10	do	S. A. Briniker	3	42	17	.....	.....	216	10	.....	.....
11	Logan	Henry Nichols	3	43	33	1892	6	200	8	80.00	.....
12	Seebarsee	J. H. Rosenkrans	1	42	2	1882	36	18	4	10.00	10.00
13	Wray	David Foreman	1	44	8	.....	.....	250	20	.....	.....
14	.....	Jno. Ramsey	4	44	9	1893	5	215	15	85.00	125.00

CHEYENNE COUNTY.

15	Cheyenne Wells	School district, city of Cheyenne Wells.	14	44	21	1893	*a* 42	265	18	.....	.....
16	do	School district No. 6	14	44	7	1890	36	181	4	$300.00	$100.00
17	do	Ella R. Williams	13	44	28	.....	.....	20	5	.....	.....
18	do	E. L. Parker	13	44	26	1890	12	15	2	10.00	50.00
19	do	U. P. R. R	....	....	....	1882	10	257	25	.....	.....

a Inches square.

KIT CARSON COUNTY.

			N.	*W.*							
20	Ashland	Wm. M. Long	6	42	3	1888	6	150	12	$60.00	$108.00
21	do	.....	6	42	3	1894	6	207	16	80.00	125.00
22	do	.....	6	42	34	1893	5½	172	12	65.00	95.00
23	Burlington	E. W. Cain	9	42	31	1893	.....	130	4	.....	75.00
24	do	Dana Shaw	9	43	35	1888	6	164	14	37.00	70.00
25	do	S. J. Jones	9	43	33	1892	8	150	10	100.00	100.00
26	do	Wm. Penfold	9	43	31	.....	.....	150	10	.....	.....
27	do	Wm. Boyles	9	44	12	1891	8	148	24	55.00	85.00
28	do	City of Burlington	8	44	36	1893	2	200	35	130.00	125.00
29	do	Adolph Hoss	8	43	19	1889	.....	160	8	70.00	125.00
30	Colorado Springs	Al. Russell	8	44	13	1888	.....	155	4	.....	75.00
31	Haigler	John Keegan	9	51	3	1892	36	78	4	50.00	.....
32	Goodland, Kans.	J. M. Willis	....	....	....	1889	6	149	22	45.00	225.00
33	Lamborn, Kans.	Wm. Rutherford	8	42	8	1889	.....	176	14	60.00	100 00
34	do	C. H. Briggs	9	42	35	1891	.....	130	4	.....	.....
35	do	L. R. Hauks	8	42	2	1890	6	165	15	65.00	125.00
36	do	Jno. Patterson	8	42	25	1892	6	119	16	40.00	40.00
37	do	A. P. Shaw	7	42	23	1889	6	167	11	85.00	107.00

Data relating to wells in Colorado—Continued.

PHILLIPS COUNTY.

No.	Post-office.	Owner of well.	Location of well.			Year completed.	Diameter.	Depth of well.	Depth of water.	Cost of—	
			T.	R.	S.					Well.	Machinery.
			N.	*W.*			*In.*	*Feet.*	*Feet.*		
38	Amherst.....	Jesse Jurgens.....	9	43	34	1891	10	180	15	$77.00	$140.00
39	.....do.....	L. E. Fair.....	8	43	18	.....	.....	174	30	105.00	95.00
40	Holyoke.....	Fred Hawkes.....	7	44	2	1890	12	136	20	30.00	.....
41	.....do.....	F. C. Churning.....	8	44	33	1887	2	140	15	.....	.....
42	.....do.....	A. T. Guthrie.....	7	45	12	1890	10	163	7	100.00	80.00
43	.....do.....	Frank Austin.....	7	45	6	1893	6	174	24	100.00	95.00
44	.....do.....	B. and M. R. R. R...	....	....	....	1887	7	175	40	.....	.....
45	.....do.....	P. B. Reynolds.....	6	44	2	1886	10	108	8	55.00	96.00
46	.....do.....	A. A. Shafer.....	7	44	12	1887	12	115	7	35.00	85.00
47	.....do.....	W. R. Whitney.....	7	43	18	1888	8	104	14	65.00	80.00
48	Lamar, Nebr....	W. C. Knapp.....	7	42	17	1893	8	120	35	70.00	50.00
49	.....do.....	Jacob Endicott (tenant).	....	....	....	.....	.....	102	12	.....	.....
50	Venango, Nebr.	Jno. Scott.....	....	....	....	1889	8	171	27	.....	.....
51	.....do.....	J. R. Gilmore.....	8	42	5	1890	.....	143	23	80.00	90.00

SEDGWICK COUNTY.

52	Amherst.....	Jno. W. Franklin...	8	44	9	1891	12	195	18	$69.00	$52.00
53	Julesburg	Uberto Gibello.....	11	44	4	1894	3	40	13	.....	10.00
54	.....do.....	C. M. Harris.....	12	43	26	1886	.....	.....	.....	.....	.....
55	.....do.....	.....	12	44	26	1893	10	30	6	18.00	75.00
56	.. .do.....	Jno. Grove.....	....	....	....	.....	.....	200	.....	.....	.....
57	.....do.....	J. P. Brown	10	43	12	1893	2	265	100	365.00	50.00
58	.....do.....	.....do.....	....	....	....	1894	12	28	4	15.00	100.00
59	.....do.....	Fred Munson	12	44	34	1891	*a* 36	21	3	12.00	110.00
60	.....do.....	U. P. R. R.....	....	....	....	.....	168	20	5	.....	.....
61	.....do.....	D. B. Morgan.....	12	44	28	.....	10	.....	.....	8.00	.....
62	.....do.....	H. M. Brown.....	12	44	28	1884	8	22	6	7.50	8.00
63	.....do.....	S. H. Carlson.....	11	45	12	1888	*a* 36	50	12	25.00	78.00
64	.....do.....	Chris. Anderson....	11	45	15	1891	*a* 48	16	4	.....	.....
65	.....do.....	H. Smith.....	12	43	30	1886	8	65	7	70.00	60.00
66	Snyder	Chris. Johnson.....	....	....	....	.....	.....	60	10	.....	.....
67	Venango, Nebr..	Conrad Rahns.....	9	42	18	1889	2	170	28	255.00	95.00
68	.....do.....	Ira Clapper	10	40	1	1887	2	265	60	335.00	65.00
69	.....do.....	C. H. Fulscher.....	....	....	....	1888	2	281	70	250.00	100.00
70	.....do.....	.....do.....	10	42	36	1893	11	177	8	93.00	68.00
71	Wray.....	W. S. Dorman.....	1	43	7	.....	.....	160	.....	.....	.....

YUMA COUNTY.

72	Seebarsee.....	A. M. Bullard.....	1	42	30	1890	6	85	20	45.00	100.00
73	.....do.....	Jacob Burrel.....	....	....	....	.....	.....	100	.....	.....	.....
74	.....do.....	Joseph Herman....	3	42	4	1894	3½	80	10	.....	.....

a Inches square.

No. 1.—Drilled well; depth of water does not vary; 250 barrels in 4 hours; can not be easily lowered; quality of water, hard; water raised by wind pump with 8-foot geared wheel; is used for domestic supply, public supply of the village, and for 200 head of cattle. Strata passed through: Soil, 2 feet; yellow marl, 68 feet; magnesia; gravel with water.

No. 2.—Dug well; depth of water does not vary; can not be lowered by pumping all day; water raised by wind pump with 8-foot wheel and 2-inch cylinder; is used for domestic supply and for 25 head of stock. Strata passed through: Soil, 3½ feet; yellow clay, 77 feet; sand, 14 feet; hard magnesia, clay, and sand, 100 feet; gravel and rock.

No. 3.—Depth of water does not vary; can not be easily lowered; water raised by wind pump.

No. 4.—Drilled well (164[1]); depth of water does not vary; can not be easily lowered; quality of water, rather hard; water raised by wind pump with 12-foot Monitor wheel; is used for domestic supply and for 25 head of stock. Strata passed through: Soil, 2 feet; yellow clay, 30 feet; rock, clay, and gravel; sand with the water. This well is 3 miles east of No. 5, but not so near the canyon. A well 1 mile north, near the top of the Arickaree canyons, is 240 feet deep.

No. 5.—Drilled well (163); depth of water does not vary; 150 barrels in 12 hours; can not be easily lowered; quality of water, medium soft; water raised by wind pump with 8-foot wheel; is used for domestic supply, for 20 head of stock, and for irrigating one-eighth of an acre. Strata passed through: Soil, 4 feet; yellow fine dirt, 96 feet; native lime, 4 feet; sand rock; water in rock.

No. 6.—Dug well; depth of water does not vary; can not be easily lowered; quality of water, rather hard. Another well near is very alkaline. Water raised by hand pump; is used for domestic supply and for some stock. Strata passed through: Alluvia to gravel. It is on the second bottom of the South Fork Republican Valley. The alkaline water indicates the proximity of shales, which crop out in the sides of the valley in places.

No. 7.—Drilled well (158); depth of water does not vary; can not be easily lowered; quality of water, not very soft; is raised by wind pump with 10-foot wheel; is used for domestic supply and for 15 head of stock. Strata passed through: Soil; rock; water in sand.

No. 8.—Drilled well (157); depth of water does not vary; not certain as to whether it lowers or not, but it is never exhausted; quality of water, soft; water raised by wind pump with 12-foot wheel; is used for domestic supply. Strata passed through: Soil, 2 feet; yellow marl, 35 feet; magnesia, 20 feet; rock (magnesia ledges), 14 feet; sand and rock streaks, 30 feet; hard, reddish clay, with bones; sand; sand and clay, and a little gravel with water.

No. 9.—Drilled well (156*a*); depth of water does not vary; 14 barrels per hour; can not be easily lowered; quality of water, rather hard; water raised by wind pump with 8-foot wheel; is used for domestic supply and for 30 head of stock. Strata passed through: Soil; sand; rock with water.

No. 10.—Drilled well.

No. 11.—Drilled well; depth of water does not vary; can be pumped continuously day and night; can not be lowered; quality of water, soft; water raised by wind pump with 8-foot geared wheel and 2-inch cylinder; is used for domestic supply and for 50 head of stock. Strata passed through: Soil, 2 feet; creamy soil, 90 feet; sand; stone; gravel with water. Wells not far east are 230 feet deep, on slightly higher land. A well 1 mile west is of the same depth as this, and has watered 160 head of cattle in dry seasons.

No. 12.—Dug well; depth of water does not vary; 200 gallons in twenty minutes can be obtained from the well, this lowering it temporarily, at which time quicksand comes in; quality of water, hard and alkaline; water raised by chain and suction pumps; is used for 1,500 head of sheep. Strata passed through: Soil; sandy yellow loam; quicksand with water.

No. 13.—Drilled well; depth of water does not vary; can not be easily lowered; quality of water, hard; is used for domestic supply. Strata passed through: As usual on this plateau south of Wray.

No. 14.—Bored well; depth of water does not vary; can not be lowered by pumping all day; quality of water, not very hard; water raised by wind pump; is used for domestic supply and for 20 head of stock. Strata passed through: Soil, 3 feet; yellow dirt, 67 feet; rock, gravel; fine gravel with the water.

No. 15.—Dug well; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by steam pump; is used for the supply of the

[1]The figures in parenthesis are the numbers given to the wells on Pl. XLII, Sixteenth Annual Report U. S. Geological Survey.

town. Strata passed through: Soil, 2 feet; creamy clay, 15 feet; sand and assorted gravel; water in gravel. There is only one well between this and the Kansas line at Chemung.

No. 16.—Dug well; depth of water does not vary; can not be easily lowered; quality of water, rather soft; water raised by wind pump with 12-foot wheel; is used for a school and for 100 head of stock. Strata passed through: Soil, 20 feet; sand, 60 feet; clay, 3 feet; sand, with a streak of rock and gravel occasionally; coarse gravel, 3 feet at water, and sugar sand below.

No. 17.—Dug and driven well; water at 15 feet, and sand point driven 5 feet into it; depth of water does not vary; can not be easily lowered; water raised by wind pump with 10-foot wheel; is used for domestic supply and some stock. Strata passed through: Soil and sand. This is on the narrow bottom of Smoky Hill River (South Fork), just west of Old Cheyenne Wells, and 10 feet above the river bed.

No. 18.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump with 8-foot wheel; is used for domestic supply. Strata passed through: Black alluvia to water; water in gravel. Another well close by supplied 400 head of stock in summer. There are 8 wells in two sections on the North Fork Smoky River bottom, but a boring 58 feet deep on higher land obtained little water.

No. 19.—Bored well; water rose slightly when struck; depth of water does not vary, except that there seems to be slightly more water when the wind is from the northwest; water obtained from the well fills 50,000-gallon tank in 48 hours; water raised by steam pump; is used by a railway division station. Some gas still comes from the old Government boring with which this well was connected. Prof. O. St. John, in an article on artesian wells in the Fourth Biennial Report of the Kansas State Board of Agriculture, has preserved the record of the Government test boring made in 1882, and it is here appended:

Section of the artesian boring at Cheyenne wells.

Formations. (*a*)	Strata.	Feet.
Plains marl	1. Surface clays	30
	2. Chalky rock	30
Tertiary grit	3. Gravelly clay	50
	4. White sandy clay	20
	5. Soft white sand	15
	6. White sandy clay	40
	7. Soft sand, alternating with clay	80
	8. Soft white clay	20
Laramie (?)	9. Soft black shale	319
Montana group	10. Soft white arenaceous shales, with gas veins at 610 and 640 feet	726
	11. Chalk rock; slight inflow of brackish water near base.	70
	12. Fine sand	30
	13. Soft black shale	100
Colorado group	14. Soft white calcareous (?) rock	50
	15. Black shale	190
	Total	1,770

a The names in the first column indicate Prof. Robert Hay's opinion as to the geological age of the strata indicated.

No. 20.—Drilled well; depth of water does not vary; can not be easily lowered; water raised by wind pump with 8-foot wheel; is used for domestic supply. Strata passed through: Soil, 3 feet; creamy clay, magnesia. This well is on the top of the bluffs overlooking canyons to Republican River. It is in a draw leading to Sand Creek.

No. 21.—Drilled well; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 50 head of stock. Strata passed through: Soil, 3 feet; yellow clay, 77 feet; sand, 3 feet; magnesia lime, 97 feet; hard stone, 10 feet; sand

and gravel to the bottom. This well is one-half mile west of No. 20, on the same quarter section, and on ground 95 feet higher by barometer, and the draws of Sand Creek, both east and west, are deep. The well at Ashland, 2 miles south, is on slightly lower ground, and is 172 feet deep, with 20 feet of water.

No. 22.—Depth of water does not vary; water can be obtained in abundance if mill runs continuously; can not be easily lowered; quality of water, hard; water raised by wind pump with 8-foot wheel; is used for domestic supply and for 30 head of stock. Strata passed through: Soil, 5 feet; creamy yellow soil, 155 feet; coarse gravel with water, 12 feet. Two wells within a mile have 12 and 16 feet of water, respectively, and another 3½ miles south has 11 feet. It is in a beaver draw, and is 139 feet to water.

No. 23.—Drilled well; depth does not vary; can not be easily lowered; quality of water, rather soft; water raised by wind pump with 8-foot wheel; is used for domestic supply and for 30 head of stock. Strata passed through: Soil, 2 feet; yellow clay; sand; rock (at 125 feet); gravel.

No. 24.—Drilled well; depth of water does not vary; 30 barrels in half a day; can not be easily lowered; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 140 head of stock. Strata passed through: Soil, 4 feet; creamy clay, 30 feet; sand, 40 feet; yellow dirt; rock, 1 foot; red clay with water.

No. 25.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump; is used for domestic supply and for 35 head of stock. Strata passed through: Soil, 6 feet; creamy yellow soil; lime; gravel with ledges of rock and sand.

No. 26.—Drilled well; water raised by wind pump; is used for domestic supply.

No. 27.—Drilled well; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump with 8-foot wheel; is used for domestic supply and for 60 head of stock. Strata passed through: Soil, 3 feet; creamy clay, 30 feet; sand, rock, and gravel to water.

No. 28.—Tubular well; depth of water does not vary; about 200 barrels per day; can not be easily lowered; quality of water, soft; water raised by wind pump with 14-foot wheel; is used for public purposes. Strata passed through: Soil, 3 feet; cream-colored clay, 4 feet; clay and sand, 140 feet; gravel (some of it cemented) to bottom. There are 4 other wells in the town besides the old railway well, not now used. These are all of the same depth to water, but the total depth is 180 to 185 feet.

No. 29.—Drilled well; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 30 head of stock. Strata passed through: Soil; creamy soil; soft rock; sand with water.

No. 30.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump; is used for domestic supply and for 20 head of stock. Strata passed through: Soil; rock; gravel.

No. 31.—Dug well; rose slightly at first; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump; is used for domestic supply and for a hotel. Strata passed through: Soil, 10 feet; magnesia; sand; magnesia; sand; gravel with water. This well is in the town of Flagler.

No. 32.—Drilled well (196); depth of water does not vary; 175 barrels in 12 hours; can not be easily lowered; quality of water, hard; water raised by wind pump with 14-foot wheel; is used for 175 head of stock and for irrigating 3 acres; tank, 35 by 80 feet. Strata passed through: Soil; clay; rock and coarse gravel. A well 1 mile west is 150 feet deep.

No. 33.—Drilled well (195); depth of water does not vary; can not be easily lowered; quality of water, rather hard; water raised by wind pump with 10-foot wheel; is used for domestic supply and for 25 head of stock. Strata passed through: Soil, 2 feet; sand, etc.

No. 34.—Bored well; depth of water does not vary; can be easily lowered because not deep enough in the water. Strata passed through: Soil; yellow clay; rock to water.

No. 35.—Drilled well (194); depth of water does not vary; 150 gallons per hour; can not be easily lowered; water raised by wind pump with 10-foot wheel; is used for domestic supply and for 160 head of stock. Strata passed through: Soil, 4 feet; creamy yellow clay, 76 feet; sand, 20 feet; reddish clay rock, 12 feet; sand and gravel, 12 feet; solid rock, 3 feet; reddish dirt, 3 feet; sand, gravel, and clay to bottom. A well 2½ miles east (in Kansas) had water at 142 feet. A well 1 mile west of No. 35 is 145 feet to water, and is on rather higher ground.

No. 36.—Drilled well; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump with 8-foot wheel; is used for domestic supply and for 10 head of stock. Strata passed through: Soil, 2 feet; creamy clay, 100 feet; reddish clay, 10 feet; gravel and sand to bottom. This well is within a few rods of the Kansas line. Bender's well, 2 miles north, also close to the line, is 162 feet deep, with 13 feet of water.

No. 37.—Drilled well; depth of water does not vary; pump running night and day frequently; can not be easily lowered; quality of water, soft; is raised by wind pump with 10-foot wheel; is used for domestic supply, for 35 head of stock, and for irrigating one-fourth of an acre. Strata passed through: Soil, 3 feet; creamy soil, 77 feet; sand, clay, magnesia; coarse sand with water. No rock.

No. 38.—Bored well; water has decreased, apparently from inflow of sand; depth of water does not vary; 500 gallons per hour, with good wind; can not be easily lowered; quality of water, soft; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 27 head of stock. Temperature, 56° F. Strata passed through: Soil, 2½ feet; dark soil, 27½ feet; gravel, 30 feet; sand and gravel, 120 feet. No hard rock.

No. 39.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, not very hard; water raised by wind pump with 8-foot wheel; is used for domestic supply and for 35 head of stock. Temperature, 54° F. Strata passed through: Soil, 6 feet; hard rock; gravel with water.

No. 40.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, not very hard; water raised by wind pump, now removed; is used for domestic supply and for stock. Strata passed through: Soil, 3 feet; yellow clay, with a little gravel, 100 feet; gravel and some yellow clay, 33 feet.

No. 41.—Driven well; depth of water does not vary; can not be easily lowered; quality of water, hard; water raised by wind pump, now removed; is used for domestic supply of many families and for their stock. Strata passed through: Not known.

No. 42.—Bored well; depth of water does not vary; 30 barrels per day; can not be easily lowered; quality of water, soft; water raised by wind pump with 8-foot wheel; is used for domestic supply, for stock, and for irrigating one-half an acre. Strata passed through: Soil; some magnesia; gravel; hard rock at 90 feet, and again at 150 feet.

No. 43.—Bored well; depth of water does not vary; can not be lowered with pump running day and night; quality of water, soft; water raised by wind pump with 8-foot wheel; is used for domestic supply, for stock, and for irrigating a small area. Strata passed through: Magnesia; streaks of hard rock and gravel; water in gravel.

No. 44.—Bored well; depth of water does not vary, though steam pump goes day and night; upward of 30,000 gallons per day; can not be lowered; quality of water, hard; water raised by steam pump, which lifts 58 gallons per stroke; is used for railway shops and for the town of Holyoke. Temperature, 56° F. Strata passed through: As usual in this district. A well only 5 feet deep in the bed of the Frenchman, only a few rods away, has the same temperature. A small area is irrigated by the water from this well.

No. 45.—Bored well; depth of water does not vary; 50 barrels per day; can not be lowered; quality of water, not very hard; water raised by wind pump with 10-foot wheel; is used for domestic supply and for 140 head of stock. Strata passed through: Soil, 5 or 6 feet; clay, 50 feet; gravel and sand.

No. 46.—Dug and drilled well; depth of water does not vary; temperature, 54° F.; can not be lowered, although mill has run several days without stopping; quality of water, nearly soft; water raised by wind pump; is used for domestic supply and for 100 head of stock. Strata passed through: Soil, 8 feet; clay and magnesia, with streaks of conglomerate; water in gravel.

No. 47.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump; is used for domestic supply and for 10 head of stock. Strata passed through: Soil, 4 feet; sand; some hard rock; water in gravel. This is a roaring well, the air rushing out of it before and during a storm. Another well to the southwest was used for irrigating a garden and a potato patch.

No. 48.—Drilled well; water was reached at 110 feet, when it rose 25 feet; depth of water does not vary; can not be lowered with pump running a day and a night; quality of water. soft; water raised by wind pump; is used for domestic supply, for 13 head of stock, and for irrigating one-third of an acre. Strata passed through: Soil; a few feet of white magnesia; a hard ledge at 90 feet; water in gravel and sand. Some wells near here are only 85 feet deep and are easily pumped dry.

No. 49.—Depth of water does not vary; water raised by windlass and buckets; is used for domestic supply and for stock. Strata passed through: Soil, 5 feet; magnesia; sand and gravel.

No. 50.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, soft. Strata passed through: Soil, 1 foot; magnesia; gravel, etc., as usual on this Platte-Frenchman plateau.

No. 51.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, medium hard; water raised by wind pump with 10-foot wheel; is used for domestic supply and for 50 head of stock; temperature, 54° F. Strata passed through: Soil, 4 feet; yellow clay (plains marl), 20 feet; sand and gravel, 40 feet; gravel, 56 feet; rock (with the water), 23 feet.

No. 52.—Bored well; depth of water does not vary; 20 barrels per day; can not be easily lowered; quality of water, not very soft; water raised by wind pump; not a very good well; water used for domestic supply and for 30 head of stock. Strata passed through: Soil, 3 feet; sand and gravel all the way down.

No. 53.—Drilled well; water rose a little when first reached; depth of water does not vary; water in abundance obtained from the well; can not be easily lowered; quality of water, soft; is used for domestic supply. Strata passed through: Magnesia all the way. This is close to the river, to which the outcrop of magnesia reaches very nearly, and the water is about the same as the underflow of the river bed, which is usually dry.

No. 54.—This is an inclosed spring which gives 4 gallons per minute steadily; quality of water, soft; water raised by hand pump and overflow pipe, which supplies a tank and reservoir and irrigates a small area; water used for domestic supply and for 375 head of cattle, which number might be more than doubled.

No. 55.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, not very hard; water raised by wind pump; is used for domestic supply and for 1,200 head of sheep. Strata passed through: Soil; gravel. There is another well within 200 feet. This well is within 30 rods of the river (south side). A well one-half mile west, on the bank of the river, gets water at 29 feet, and the river bank is nearly 20 feet high.

No. 56.—Bored well; depth of water does not vary; can not be easily lowered.

No. 57.—Depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump with 12-foot wheel; it is used for domestic

supply and for 20 head of stock. Strata passed through: Soil, 6 inches; gravel; magnesia; clay and gravel. A well 1 mile south is 246 feet deep, and another 1 mile west is over 200 feet in depth.

No. 58.—Bored well; depth of water does not vary; 1,500 gallons per hour; can not be easily lowered; water raised by wind wheel and Hay's pump; is used for irrigation.

No. 59.—Dug well; depth of water does not vary; 1,200 gallons per hour; can not be easily lowered; quality of water, hard; water raised by wind pump with 4-inch cylinder; is used for irrigation, being held in a cemented tank. Strata passed through: Sand; soil; clay or magnesia; hard sand and gravel. This well is on the south side of the river, just east of Julesburg bridge. Another well close by is 18 feet to water, and has a 12-foot wind wheel, which, with steady wind, raises 1,800 gallons per hour.

No. 60.—Dug well; depth of water does not vary; water obtained from the well will fill 50,000-gallon tank in 4 hours; can be lowered by the steam pump, but the water level is soon restored; quality of water, soft; water raised by steam pump; is used for supplying a railway roundhouse and for other purposes. Strata passed through: River alluvia.

No. 61.—Bored well; depth of water does not vary; not tested as to quantity; can not be easily lowered; quality of water, hard; water raised by hand buckets; is used for domestic supply and by the traveling public. Strata passed through: Soil, 2 feet; light-colored clay and dark-blue clay, 8 feet; sand to water.

No. 62.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, hard; water raised by hand pump; is used for domestic supply and for a large hotel. Strata passed through: Soil; sand; gravel. This well is in the town of Julesburg. There are over 30 wells in the town, which is situated on the South Platte bottom, on the north side of the river.

No. 63.—Dug well; water rose a few feet; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump; is used for domestic supply, for 400 head of stock, and for irrigating 1 acre. Strata passed through: Soil, 2½ feet; gravel, 2½ feet; magnesia, 1 foot; gravel and sand, 34 feet; hardpan (blue hard clay), 10 feet.

No. 64.—Dug well. This is a spring well, the water creating a marsh along the edge of the hill, in the slope of which the well is made. Depth of water does not vary; 60 to 70 gallons per minute; can not be lowered; quality of water, soft; water raised by wind pump; is used for domestic supply, for a few head of stock, and irrigates 15 acres from a reservoir of about 10 feet square. Strata passed through: Soil; red material; gravel; magnesia and sandy cemented gravel. Temperature, 58° F., apparently influenced by the atmosphere, it being an open well.

No. 65.—Bored well; depth of water does not vary; can not be easily lowered; water raised by wind pump with 10-foot wheel; is used for domestic supply, for 50 head of stock, and for irrigating one-half an acre. Strata passed through: Soil, 1 foot; sand. This well is on the second slope, on the south side of South Platte, which is 1½ miles distant.

No. 66.—Depth of water does not vary; can not be easily lowered; water raised by wind pump; is used for domestic supply and for 100 head of stock. Strata passed through: Magnesia.

No. 67.—Drilled well; depth of water does not vary; water obtained from the well will supply 60 teams daily; can not be easily lowered; quality of water, soft; water raised by wind pump; is used for domestic supply and for stock. Strata passed through: Soil, and layers of hard rock above the water gravel.

No. 68.—Drilled well; depth of water does not vary; can not be easily lowered; quality of water, not very hard; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 40 to 50 head of stock. Strata passed through: Magnesia; sand and gravel.

No. 69.—Drilled well; depth of water does not vary; 50 to 60 barrels per day; can not be easily lowered; quality of water, not very hard; water raised by wind pump with 14-foot wheel; is used for domestic supply and for 50 head of stock. Strata passed through: Soil, 4 feet; magnesia; gravel; loam; gravel.

No. 70.—Bored well; depth of water does not vary; 60 barrels per day; can not be easily lowered; quality of water, not very hard; water raised by aermotor with 8-foot wheel; supplies 70 head of stock and irrigates 1 acre. Strata passed through: Soil, 1½ feet; magnesia, 10 feet; gravel, 12 feet; clay and gravel, 25 feet; gravel, 18 feet; magnesia, 102 feet; gravel, 8 feet.

No. 71.—Bored well; depth of water does not vary; can not be easily lowered; water raised by wind pump; is used for domestic supply, for 50 head of stock, and for irrigating a garden. Strata passed through: Soil, 2 feet; yellow clay and sand; rock; gravel; water in rock.

No. 72.—This, with the following wells, is on the Republican (North Fork) Arickaree divide. Jordan's well, 1 mile farther west, is 130 feet deep; another well, 7 miles from Burrel's, is 175 feet deep; and yet another, at Galilean, 9 miles from Burrel's, is 190 feet deep. Beyond this the wells have not so great a depth.

No. 73.—Drilled well; rose slightly; depth of water does not vary; can not be easily lowered; water raised by wind pump; is used for domestic supply, for stock, and for irrigation. Strata passed through: Sandy soil, 1 foot; sand 10 feet; quicksand, 25 feet; clay, 2 feet; gravel with water, 6 feet; gravel and streaks of clay, dividing the water into layers, 36 feet. This well is in the sand hills.

No. 74.—Depth of water does not vary; can not be easily lowered; water raised by wind pump; is used for domestic supply and for stock. Strata passed through: Clay, magnesia, gravel, etc. This well is on the bluffs south of Wray. The wells in the valley at Wray are from 15 to 25 feet in depth, and the water in some of them rises to a height of 10 feet.

Data relating to wells in Kansas.

CHEYENNE COUNTY.

No.	Post-office.	Owner of well.	Location of well.			Year completed.	Diameter.	Depth of well.	Depth of water.	Cost of—	
			T.	R.	S.					Well.	Machinery.
							In.	*Feet.*	*Feet.*		
1	Benkelman, Nebr	Peter Courtright...	....	....	....	1893	12	85	35	$34.00	.....
2	Gurney.....	Old town of Gurney	3	42	26	.....	.....	200	3	.....	.....
3	.....do	Hemen B. Rice.....	....	....	....	1890	3	200	9	185.00	$65.00
4	Haigler, Nebr ..	Isaac M. Clark	1	42	3	1889	*a* 30	24	5	.....	.....
5	.....do	Harry Clark	2	42	1	1894	36	19	1	5.00	.....
6	.....do	C. M. Corbett.....	3	42	4	.....	.....	240	.....	.....	.....
7	.....do	S. E. Gulliams	1	41	31	1887	42	85	5	20.00	75.00
8	.....do	F. H. Rose.....	1	41	23	1890	36	30	5	10.00	100.00
9	.....do	Charlee Zonge	1	41	24	1888	42	80	10	25.00	100.00
10	Jaqua, Kans....	W. J. Baker	5	42	28	1890	6	98	18	40.00	50.00
11	.....do	E. M. Collins.....	4	42	33	1894	8	17	10	10.00	7.50
12	Lawnridge	J. A. Clinger.....	....	....	....	.....	.....	215	10	.....	.....
13	.....do	Frank Vanschowm.	4	40	27	.....	.....	190	20	.....	.....
14	.....do	....	5	39	19	1893	2	190	5	125.00	.....
15	Lansing, Col....	R. Cassens.....	3	42	8	1893	12	222	7	90.00	100.00
16	Lawnridge	C. H. Tromble	....	....	....	1887	6	210	14	150.00	200.00
17	St. Francis	H. H. Griffiths.....	5	40	19	1891	6	210	15	.....	.....
18	.....do	Old town of Wano .	....	....	....	1889	36	23	0	12.00	.....
19	.....do	John Bear.....	4	40	4	1886	66	65	5	20.00	25.00
20	.....do	Pat McCloskey.....	3	40	9	1888	6	35	5	16.00	125.00
21	.....do	O. C. Blackburn	3	40	22	1890	36	25	3	.....	.....
22	.....do	B. F. Campbell.....	3	40	22	1888	36	18	3	15.00	.....
23	.....do	J. W. Tucker.....	2	41	7	.....	.....	175	0	.....	.....
24	.....do	J. S. Patton.....	4	40	5	1893	1¼	19	9	15.00	40.00
25	.....do	W. H. Wellmeyer..	3	40	32	1893	2	40	5	40.00	35.00
26	.....do	....	3	41	33	1893	5¼	203	3	83.00	75.00
27	.....do	L. J. Nettleton.....	....	....	....	1887	36	225	20	.....	.....
28	.....do	J. J. Finnegan.....	5	40	26	1888	36	140	3	75.00	112.00
29	.....do	John Bridges.....	3	41	28	1892	6	190	16	171.00	151.00

a Inches, square.

Data relating to wells in Kansas—Continued.

CHEYENNE COUNTY—Continued.

No.	Post-office.	Owner of well.	Location of well.			Year completed.	Diameter.	Depth of well.	Depth of water.	Cost of—	
			T.	R.	S.					Well.	Machinery.
30	St. Francis	Dolph Gibboney	3	41	25	1889	6	120	12	72.00	65.00
31	do	J. B. Gillespie	3	39	4	1889	6	69	11	24.00	88.00
32	do	G. Reile	2	41	25	1889	36	118	6	30.00	110.00
33	do	D. F. Lyman	3	40	6	1886	46	130	5	30.00	85.00
34	do	M. W. Benson	3	40	23	.....	6	52	8	15.00	80.00
35	do	A. E. Small	3	40	24	1892	5	106	11	45.00	75.00
36	Wheeler	Town well	3	39	28	1887	3	190	50	.....	.....
37	do	Wm. Bridgefort	....	....	....	.....	.....	172	12	.....	.....
38	do	W. E. Hotchkiss	3	39	27	1888	6	210	10	100.00	130.00
39	do	Chas. Pritchett	4	39	9	1889	2	215	100	215.00	140.00
40	do	Sam Wilson	....	....	....	1889	6	203	15	.....	.....
41	do	S. Jackson	4	39	3	1893	2	155	15	120.00	80.00
42	do	Henry Sump	1	28	35	1892	4	446	.....	.....	.....
43	do	Frank Williams	3	39	14	1892	6	173	20	68.00	100.00

SHERMAN COUNTY.

44	Klink	B. F. Hunraker	9	42	1	1892	6	112	12	$36.00	$94.00
45	do	O. M. Fee	8	42	36	1891	9	116	10	25.00	20.00
46	Goodland	T. R. Roupe	8	40	14	1894	3	.....	.....	32.00	110.00
47	do	L. A. Chatfield	8	40	18	1892	6	109	14	50.00	.....
48	do	Frank Sylvester	8	41	25	1890	8	60	9	.....	80.00
49	do	F. L. Jones	8	40	28	1888	.....	126	10	.....	40.00
50	do	J. M. Whistenaud	8	40	35	1887	6	140	16	84.00	.....
51	do	C. Campbell	8	39	32	1888	2½	140	11	100.00	.....
52	do	C. O. Miller	....	....	....	1893	8	122	8	.....	.....
53	do	John Sullivan	8	40	34	1889	6	132	15	60.00	85.00
54	do	Andrew Frydandall	10	40	2	1891	36	100	3	.....	.....
55	do	D. J. Byran	9	39	31	1888	2½	94	5	56.00	.....
56	do	W. S. Cochran	7	41	24	1888	12	76	10	.....	50.00
57	do	John K. Buss	7	41	2	1891	2	180	50	122.00	68.00
58	do	John Carden	6	39	31	1889	12	136	5	58.00	100.00
59	do	.....	7	39	7	1886	36	55	14	15.00	90.00
60	do	Wm. Thacker	8	39	6	1892	12	122	13	45.00	70.00
61	do	R. I. R. R	8	39	19	1888	*a* 180	176	19	.....	.....
62	do	Henry J. Fletcher	8	41	1	1891	12	130	12	68.00	84.00
63	do	Gus Anderson	8	40	8	1893	.....	115	10	.....	.....
64	do	M. Prunesky	8	40	10	1893	2	150	10	90.00	100.00
65	do	A. Fender	8	40	12	1887	6	140	20	56.00	100.00
66	do	Commissioners of Sherman County.	8	39	19	1894	10	180	15	90.00	310.00
67	do	Mrs. Cushman	8	40	1	1894	.....	146	20	60.00	110.00
68	do	C. C. Prideaux	7	39	7	1891	48	30	2	15.00	10.00
69	do	Ira Wilson	6	40	36	1893	4½	156	8	70.00	100.00
70	do	W. M. Dice	6	40	3	.....	12	148	8	.....	.....
71	Griswold	J. H. Hart	10	42	5	1889	6	125	13	.....	97.00
72	do	A. B. Pantyer	10	42	20	1892	9	75	10	30.00	75.00
73	do	W. G. Tittle	9	42	20	.....	36	115	4	60.00	85.00
74	do	J. Crosby	9	42	4	1886	36	100	3	80.00	115.00
75	La Blanche	A. W. Monk	9	41	26	1889	6	120	36	50.00	60.00
76	do	.....	9	41	34	.....	.....	138	36	.....	.....
77	Lamborn	Town of Kanorado.	8	42	29	1888	8	120	20	55.00	75.00
78	do	A. C. Brown	8	42	20	1889	6	120	18	50.00	75.00
79	do	J. Q. Thompson	8	42	16	.....	.....	110	.....	.....	.....
80	do	Jno. Geisinger	8	42	5	.....	.....	142	14	.....	.....
81	do	Jno. Christenson	7	42	8	1892	9	160	9	50.00	86.00
82	do	A. Swann	9	42	21	1889	.....	122	9	.....	.....
83	do	The. Laurent	8	42	22	1889	6	105	20	35.00	80.00
84	do	H. Hartstine	8	42	29	1892	9	118	18	42.00	85.00
85	Ruleton	J. E. Hill	8	41	5	1892	8	70	18	30.00	80.00
86	do	Charles Alin	8	41	34	1886	8	135	10	.....	.....
87	do	Town of Ruleton	8	41	22	.....	.....	114	30	.....	.....
88	do	.....	8	41	23	.....	.....	103	5	.....	.....
89	do	Wm. Buckridge	7	41	36	.....	10	96	10	.....	.....
90	do	Jno. Boden	6	41	11	1894	2	198	63	70.00	180.00
91	do	.....	6	42	8	.....	.....	213	20	.....	.....
92	do	.....	7	42	17	.....	.....	106	7	.....	.....
93	do	Anthony Hengstler	9	42	8	1892	6	135	15	.....	.....
94	do	A. B. Montgomery	8	39	19	1894	.....	181	40	.....	.....

a Inches, square.

Data relating to wells in Kansas—Continued.

WALLACE COUNTY.

No.	Post-office.	Owner of well.	Location of well.			Year completed.	Diameter.	Depth of well.	Depth of water.	Cost of—	
			T.	R.	S.					Well.	Machinery.
							In.	*Feet.*	*Feet.*		
95	Lester	L. Eitle	12	42	10	1893	12	108	19	$45.00	$95.00
96	do	W. F. Corden	11	42	24	1893	36	65	4	25.00	.....
97	do	G. L. Baughman	11	40	2	1888	42	76	8	40.00	85.00
98	Presley	Oscar Post	11	40	14	1889	48	125	5	.....	.....
99	Sharon Springs.	N. A. Ferlen	....	....	....	1894	48	39	18	12.00	100.00
100	do	Hugh Graham	13	40	26	1894	48	44	16	15.00	102.00
101	do	J. M. Ewell	13	40	26	1894	48	38	12	15.00	99.00
102	do	Samuel Halsey	12	41	22	1889	72	20	4	20.00	65.00
103	do	B. G. Hurlburt	13	40	34	1891	.....	24	14	10.00	180.00
104	do	N. W. Hayes	13	40	20	1888	60	21	3	10.00	.....
105	do	W. M. Swartz	13	41	24	1890	72	50	5	35.00	.....
106	do	J. M. Ericson	13	40	27	1894	72	27	7	11.00	105.00
107	do	.....	13	40	24	1887	*a* 36	20	3	5.00	.....
108	do	H. H. Yost	13	39	30	1893	60	40	4	20.00	15.00
109	do	Wm. Blodgett	14	40	12	1893	6	135	12	37.50	56.00
110	do	.....	13	41	34	1888	42	36	12	15.00	.....
111	do	Water Co	13	40	27	1889	72	35	5	.....	150.00
112	do	J. Gorsuck	13	40	22	.....	30	.....	.....	.....	.....
113	Wallace	Geo. Allman	13	39	26	1884	1½	13	2	19.00	.....
114	Weskan	S. D. Yoxall	13	42	24	1885	36	10	2	.....	.....
115	do	C. E. Seed	13	42	34	1894	6	159	18	60.00	70.00
116	do	U. P. R. R	14	42	2	1880	180	143	7	.....	.....
117	do	Samuel Johnson	13	42	32	1894	36	40	7	.....	.....
118	do	Schoolhouse	12	42	10	1894	6	130	12	65.00	.....
119	do	Laycock's ranch	....	....	....	.....	.....	14½	1	.....	.....
120	do	.....	....	....	....	.....	.....	68	15	.....	.....

a Inches, square.

No. 1.—Bored well; depth of water does not vary; can be lowered with a bucket; quality of water, soft, but salty; water raised by hand buckets; is used for domestic supply. Strata passed through: Soil, 3 feet; sand, 26 feet; blue shale, 56 feet.

No. 2.—Now closed (156[1]). Two wells, a mile west, each have a depth of 175 feet.

No. 3.—Drilled well (155); depth of water does not vary; 180 barrels per day; can not be easily lowered; quality of water, medium hard; water raised by wind pump with 8-foot wheel; is used for domestic supply and for 100 head of stock. Strata: Soil, 15 feet; whitish clay, magnesia rock; sand, gravel with water.

No. 4.—Dug well (139); depth of water does not vary, but has decreased from caving; quality of water, hard; water raised by pulley and bucket; is used for domestic supply. Strata passed through: Soil, 2 feet; yellow dirt; sand, blue clay (shale) with water in top. This well is on the Arickaree bottom.

No. 5.—Dug well; depth of water does not vary; 3 barrels per hour lowers it, but the level is restored in half an hour; quality of water, hard; water raised by pulley and buckets; is used for domestic supply and 8 head of horses. Strata passed through: Soil, 1 foot; yellow clay, 13 feet; fine, hard sand, 3½ feet; gravel, 1½ feet.

No. 6.—Drilled well (168); depth of water does not vary; can not be easily lowered; quality of water, hard; water raised by wind pump.

No. 7.—Dug well; depth of water does not vary; 4 to 5 barrels per hour; can not be easily lowered; quality of water, medium soft; water raised by wind pump with 8-foot wheel; is used for domestic supply and for 26 head of stock. Strata passed through: Soil, 2 feet; yellow clay to water; soapstone with water at top.

No. 8.—Dug well; depth of water does not vary; can be lowered, but the level is soon restored; water raised by wind pump with 8-foot wheel; is used for domestic supply, for 30 head of stock, and from 60 to 70 hogs. Strata passed through: All yellow clay; water in quicksand. This well is in a canyon on the Hackberry, very deep, the yellow clay (plains marl) rising high all around.

[1] The figures in parentheses are the numbers given to wells on Pl. XLII, Sixteenth Annual Report.

No. 9.—Dug well; depth of water does not vary; 8 to 10 barrels per day; can be lowered by several hours pumping; quality of water, soft; water raised by wind pump with 10-foot wheel; is used for domestic supply and for 30 head of stock. Temperature, 57° F. Strata passed through: Soil, 4 feet; yellow clay and sand, 60 feet; sand and gravel, with water, 10 feet. This well is in a draw leading to Hackberry Creek.

No. 10.—Drilled well; depth of water does not vary; can not be easily lowered; quality of water, soft; is used for domestic supply, for 40 head of stock, and for irrigating a small garden. Strata passed through: Soil, 10 feet; magnesia rock, 70 feet; gravel; rock and gravel, with water, 18 feet. A (229) well on the northwest quarter of section 22 is 136 feet deep, with 20 feet of water.

No. 11.—Bored well (230); depth of water does not vary; can not be easily lowered; quality of water, medium soft; water raised by hand pump; is used for domestic supply and for stock. Strata passed through: Sandy alluvia of the Republican bottom. The water in the well is more abundant since the completion of the Ericson irrigation ditch, which is distant about a quarter of a mile. The water in the well increased 10 days after water had been turned into the ditch.

No. 12.—Depth of water in well (177) does not vary; can not be easily lowered.

No. 13.—Drilled well; depth of water does not vary; can not be easily lowered; quality of water, hard; water raised by wind pump.

No. 14.—Drilled well (246); depth of water does not vary; can not be easily lowered; quality of water, hard; water raised by wind pump; is used for domestic supply and for 25 head of stock. Strata passed through: Soil; yellow clay; rock; sand and gravel at the water.

No. 15.—Drilled well; depth of water does not vary; water can be pumped from the well continuously without lowering the level; quality of water, medium hard; water raised by wind pump with 10-foot wheel; is used for domestic supply and for 60 head of stock. Strata passed through: Soil, 3 feet; yellow sandy clay, 100 feet; magnesia; rock; gravel with water. A well to the north, on lower ground, is 206 feet deep.

No. 16.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 250 head of stock. Strata passed through: Soil, 4 feet; cream-colored canyon clay; magnesia rock; gravel at water.

No. 17.—Bored well; depth of water does not vary; 1,200 gallons per hour; can not be easily lowered; quality of water, rather soft; water raised by wind pump with 12-foot wheel; is used for domestic supply, for stock, and for irrigating one-half acre. Strata passed through: Soil, 3 feet; creamy yellow subsoil, etc. On the Beaver bottom, to the south, is Birkner's well, 130 feet deep, with 11 feet of water—sec. 29, T. 5, R. 40.

No. 18.—Dug well; has no water. Strata passed through: Soil, sand only slightly damp; soapstone (shale). Other wells near have abundance of water, not reaching the shale.

No. 19.—Dug well; water was found at bottom and rose 5 feet; depth of water does not vary; can not be easily lowered; quality of water, medium hard; water raised by hand pump; is used for domestic supply and for 40 head of stock. Strata passed through: Soil, 2 feet; yellow soil, 10 feet; rock, 28 feet; yellow sand, 4 feet; rock, 15 feet; rock of reddish tint, 5 feet; gravel with water, 4 inches. Half a mile north, in a ravine, a well has water at 14 feet.

No. 20.—Drilled well; depth of water does not vary; can not be easily lowered; water raised by wind pump with 10-foot wheel; water used for domestic supply, for 60 head of stock, and for irrigating one-fourth of an acre. Strata passed through: Soil, 1 foot; sandy loam, 29 feet; coarse gravel, 5 feet. This well is in a draw.

No. 21—Dug well; depth of water does not vary; can not be easily lowered; water raised by hand pump; is used for domestic supply. Strata passed through:

Soil; sandy loam to bottom; but the last 5 feet had shale diagonally across the well. Every house in the town has a well, eight of these being supplied with wind pumps. E. S. Flannrey sunk a well 36 feet, 10 feet being in shale, and got no water. A few feet away he got the usual abundant supply at 26 feet, without shale.

No. 22.—Dug well; depth of water does not vary; the supply is inexhaustible; can not be lowered; quality of water, soft; water raised by hand pump; is used for stock of all kinds. Strata passed through: Sandy alluvia, with a streak of black soil 6 inches thick about 12 feet down; gravel below with water.

No. 23.—No water. Strata passed through: Yellow clay, 135 feet; shale, 40 feet. This well was sunk near the head of Hackberry Creek, in the vicinity of head of draws to Arickaree. The shale was also reached, without water, at Joel Taylor's, on the SW. ¼ of sec. 30, T. 1 S., R. 41, 4 miles north of Tucker's, and at a few other places in this region.

No. 24.—Driven well; depth of water does not vary; 7½ barrels per hour; can not be easily lowered; water raised by wind pump with 9-foot wheel; is used for domestic supply, for 25 head of stock, and for irrigating one-fourth of an acre. Strata passed through: Sand and gravel. This well is in a ravine where Mr. Wellmeyer (of No. 25) has impounded springs, which come from under the magnesia, for irrigation, having a reservoir 16 by 100 by 2½ feet.

No. 25.—Tubular well (170); depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 10 head of stock. Strata passed through: Soil, 1 foot; magnesia; sand rock, 35 feet; shale, 4 feet.

No. 26.—Drilled well (169); depth of water does not vary; can not be easily lowered; quality of water, rather hard; water raised by wind pump with 8-foot wheel; is used for domestic supply and for 30 or 40 head of stock. Strata passed through: Soil, 5 feet; yellow clay; magnesia; hard gravel; gravel rock, 35 feet, with water. A well on high ground, southwest, is 235 feet deep.

No. 27.—Dug weli (168*a*); depth of water does not vary; 100 barrels in a day; can not be easily lowered; quality of water, medium soft; is used for domestic supply. Strata passed through: Soil; marl, 90 feet; sand, 4 feet; rock, 3 feet; sand, 1 foot; rock, about 70 feet, etc.

No. 28.—Dug well (179); depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 40 head of stock. Strata passed through: Soil, 4 feet; yellow creamy clay; rock; gravel. This well is on the north slope of Beaver Creek, south of Lawnridge.

No. 29.—Drilled well (154); depth of water does not vary; with pump running constantly, can not be easily lowered; quality of water, medium soft; water raised by wind pump, 8-foot aermotor; is used for 40 head of stock, for domestic supply, and for irrigating a small garden. Strata passed through: Soil, 3 feet; yellow soil, 47 feet; rock (magnesia and sandstone); hard sand rock with water.

No. 30.—Bored well (152); depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 65 head of stock. Strata passed through: Soil, 1 foot; yellow clay, 50 feet; sand; gravel with water. A mile west is a well 120 feet deep, and a mile north of that is one 135 feet in depth.

No. 31.—Drilled well; depth of water does not vary; 150 barrels per day; can not be easily lowered; has decreased slightly by inflow of sand, but will be cleaned out; quality of water, hard; water raised by wind pump with 8-foot "Gem" wheel; is used for domestic supply and for 25 head of stock. Strata passed through: Soil, 4 feet; yellow packed sand, 4 feet; coarse sand, 5 feet; rock and sand, 27 feet; magnesia, 28 feet; honeycomb rock with water, 1 foot. This well is on a ridge between canyons. A well in a canyon in section 9 has water at 20 feet, and in southeast of section 5 the water is at the surface in the canyon.

No. 32.—Dug well; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump; is used for domestic supply and for 20 head of stock. Strata passed through: Soil; yellow clay; sand. This well is on the Hackberry and South Fork Republican divide.

No. 33.—Dug well; water rose 1½ feet from second sheet to first sheet; depth of water varied at first, but does not do so now; 250 barrels per day; can be easily lowered to second sheet, but no farther; water raised by wind pump with 10-foot wheel; is used for domestic supply, for 100 head of stock, and for irrigating 3 to 5 acres. Strata passed through: Soil, 7 feet; yellow sandy clay, 60 feet; reddish clay, 20 feet; sand with rock, 30 feet; rock, magnesia, and sand, 9 feet; gravel with water, 4 feet. At 87 feet and 97 feet bones were found.

No. 34.—Dug and drilled well (144); depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 30 head of stock. Strata passed through: Soil; gravel.

No. 35.—Drilled well (145); depth of water does not vary; can not be easily lowered; quality of water, medium soft; water raised by wind pump with 10-foot wheel; used for domestic supply and for 25 head of stock. Strata passed through: Soil, 2 feet; ashy white clay; gravel; magnesia; gravel with water.

No. 36.—Drilled well (146); depth of water does not vary; can not be easily lowered; quality of water, rather hard; water raised by wind pump; is used by all the neighborhood. Strata passed through: Soil; yellow soil; magnesia; gravel.

No. 37.—Drilled well; depth of water does not vary; can not be easily lowered; water raised by wind pump; is used for domestic supply and for stock. Another well, one-half mile south and one-half mile west of No. 37, is 175 feet deep and has 13 feet of water.

No. 38.—Drilled well (147); depth of water does not vary; can not be easily lowered; quality of water, not very hard; water raised by wind pump with 10-foot wheel; is used for domestic supply, for 60 head of stock, and for irrigating a small area. Strata passed through: Soil, 1 foot; yellow clay (plains marl), 40 feet; magnesia and red clay, 120 feet; sand, 40 feet; gravel, 10 feet.

No. 39.—Tubular well (148); water was found at bottom, and rose 100 feet, remaining at that level; depth of water does not vary; 75 to 100 barrels per day; can not be easily lowered; quality of water, medium soft; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 100 head of stock. Strata passed through: Soil, 2 feet; yellow clay, 60 feet; rock and reddish magnesia; coarse gravel with water. There were two smaller sheets of water above the main supply, which seemed to rise to the level of the highest.

No. 40.—Drilled well (178); depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump; is used for domestic supply and for 75 head of stock. Strata passed through: Soil, 8 feet; yellow clay; magnesia; water in gravel. Pearson's well, 1 mile north and 1 mile east, is 240 feet deep.

No. 41.—Tubular well (149); depth of water does not vary; 70 barrels per day; can not be easily lowered; quality of water, medium soft; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 50 head of stock. Strata passed through: Soil; yellow clay; gravel. Another well on the same section gave the following record: Soil, 6 feet; yellow sand, 8 feet; rock magnesia, 5 feet; white magnesia, 15 feet; yellow sand and pink rock, 165 feet; coarse gravel and sand with water, 1 foot. Other wells give water at same horizon.

No. 42.—Drilled well; depth of water does not vary; can not be easily lowered; water used for domestic supply. Strata passed through: Soil, etc., 75 feet; soapstone, 75 feet; blue shale, 296 feet.

No. 43.—Bored well; depth of water does not vary; 10 barrels per hour; can not be easily lowered; quality of water hard; water raised by wind pump; is used for

domestic supply and for 20 head of stock. Strata passed through: Soil, 3 feet; yellow soil, 50 feet; sandy rock, 10 feet; red clay and sand, 90 feet; quicksand, 20 feet.

No. 44.—Bored well; depth of water does not vary; nearly 6,000 gallons per day; can not be lowered; quality of water, soft; water raised by wind pump with 8-foot wheel; is used for domestic supply, for 60 head of stock, and for irrigating three-fourths of an acre. The tank, which is 28 feet by 28 by 1 foot, is filled in one day. Strata passed through: Soil, 3½ feet; creamy "badger dirt," 36½ feet; sand and gravel, 72 feet; blue clay (shale?) at bottom.

No. 45.—Bored well; depth of water does not vary; can not be easily lowered; water raised by wind pump with "Jumbo" wheel; is used for domestic supply and for 10 head of stock. Strata passed through: Soil, 2 feet; creamy clay; magnesia; sand and gravel.

No. 46.—Drilled well; depth of water does not vary; can not be easily lowered; quality of water, rather hard; water raised by wind pump with 8-foot wheel; is used for domestic supply and for 60 head of stock. This well is on the slope of the Sappa, where the gravel is very near the surface. Strata passed through: Soil; clay; sand rock; sand and gravel with the water.

No. 47.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, not very hard; water raised by rope and pulley; is used for domestic supply and for 20 head of stock. Strata passed through: Soil, 2 feet; yellowish clay, 25 feet; sand, 50 feet; sand-rock streaks, 3 feet; reddish rock and sand, 15 feet; sand and gravel, 14 feet. A well on the northwest quarter of section 20 is 10 feet deeper to water, but is on slightly higher ground.

No. 48.—Bored well; depth of water does not vary; 4 barrels per hour; can not be easily lowered; quality of water, rather hard; water raised by wind pump with 8-foot wheel; is used for domestic supply and for 20 head of stock. Strata passed through: Soil, 3 feet; creamy clay, 25 feet; soft magnesia with harder streaks, 20 feet; sand, quicksand, and coarse gravel at bottom. This well is in a Beaver draw.

No. 49.—Drilled well; depth of water does not vary; can not be easily lowered; water raised by wind pump; is used for domestic supply and for 30 head of stock. Strata passed through: Soil, 5 feet; creamy soil; salt rock; sand.

No. 50.—Bored well (217); depth of water does not vary; an abundance of water is obtained from the well; can not be easily lowered; quality of water, soft; water raised by wind pump with 8-foot wheel; is used for domestic supply and for stock. Strata passed through: Soil, 5 feet; creamy clay; reddish clay; sand with water. A well one-half mile north by east of section 25 is 135 feet deep and has supplied the town (Goodland) and a herd of 75 cattle all summer; temperature, 57° F.

No. 51.—Dug originally, now tubular well (216); depth of water does not vary; can not be easily lowered; quality of water, rather hard; water raised by wind pump with 10-foot wheel; is used for domestic supply and for 25 head of stock. Strata passed through: Not known; water in gravel and sand.

No. 52.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, rather hard; water raised by wind pump with 10-foot wheel; is used for domestic supply and for 30 head of stock. Strata passed through: Soil; rock; gravel with water. A well 300 feet away is as well supplied.

No. 53.—Drilled well (215); depth of water does not vary; can not be easily lowered; quality of water, rather hard; water raised by wind pump with 10-foot wheel; is used for domestic supply and for 25 head of stock. Strata passed through: Soil; creamy soil; rock; gravel; sand.

No. 54.—Dug well (261); depth of water does not vary; can not be easily lowered, but at times needs to be made deeper; water raised by pulley and buckets; is used for domestic supply and for 10 head of cattle. Strata passed through: Soil, 2 feet; creamy clay; sand; gravel. A well on the northwest quarter of section 3 is 78 feet deep, with 6 feet of water. It is in a depression of a Smoky draw.

No. 55.—Tubular well (260); depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump; is used for domestic supply and for 100 head of stock, besides irrigating one-fourth of an acre, which area is to be increased; tank, 24 by 30 feet. Strata passed through: Soil, 2 or 3 feet; creamy soil; gravel with water.

No. 56.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump with 10-foot wheel; is used for domestic supply, for 50 head of stock, and for irrigating over one-fourth of an acre; tank, 40 by 60 feet. Strata passed through: Soil, 2 feet; yellow clay; clay and magnesia to bottom. This well is within a few feet of the bottom land of the Middle Beaver. The bottom is one-quarter of a mile wide.

No. 57.—Drilled tubular well; water rose slightly when first struck; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump with 10-foot wheel; water used for domestic supply, for 6 head of stock, and for irrigation; has a reservoir 45 by 45 by 4 feet. Strata passed through: Soil, 4 feet; creamy clay, 30 feet; magnesia and rock with alternations of sand; water in gravel.

No. 58.—Bored well (245); depth of water does not vary; can not be easily lowered; quality of water, rather hard; water raised by wind pump with 10-foot wheel; is used for domestic supply, for 100 head of stock, and for irrigating one-half acre of garden and some trees. Strata passed through: Soil; yellow clay; magnesia; gravel with water. This well is in a depression of a Beaver draw. A well (245*a*) on section 18 of the same township is 155 feet deep, with 15 feet of water.

No. 59.—Dug to water; tubular well (244); depth of water does not vary; can not be easily lowered; quality of water, rather soft; water raised by wind pump with 10-foot wheel; is used for domestic supply and for 120 head of stock. Strata passed through: Soil, 1½ feet; yellowish white clay, 15 feet; sand, 16 feet; reddish clay 8 feet; sand and gravel to bottom.

No. 60.—Bored well (243); depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump with 10-foot wheel; is used for domestic supply and for 15 head of stock. Strata passed through: Soil, 3 feet; creamy flour clay, 57 feet; sand and magnesia to water; coarse gravel with the water. A well (243*a*) 1 mile north of No. 60 is 70 feet deep, with 10 feet of water; is situated in a beaver draw.

No 61.—Dug well; depth of water does not vary; can be lowered to 5 feet, but not below that level; water raised by steam pump; is used for railway tanks, hotel, and cottages; 6,400 barrels per day is used for railway only. Strata passed through: Soil, 5 feet; creamy clay, 30 feet; reddish clay with streaks of sand; sand; gravel with the 19 feet of water. There is a drilled well 75 feet away, 180 feet deep, with 19 feet of water, which is operated by a steam pump. These wells have been in constant use, the last for 4 years. They are three-fourths of a mile from the city wells, which are also pumped by steam.

No. 62.—Bored well (195); depth of water does not vary; 10 barrels per day; can not be easily lowered; quality of water, soft; water raised by wind pump with 8-foot wheel; is used for domestic supply, for 80 head of stock, and for irrigating one-quarter of an acre; tank, 31 by 60 feet. Strata passed through: Soil, 5 feet; creamy flour soil, 8 feet; magnesia dirt, 7 feet; magnesia with hard streaks, 98 feet; sand, 8 feet; sand and gravel, 4 feet. A well one-fourth of a mile southeast gets water at the same depth (118 feet), but was bored deeper to 137 feet, thus giving 19 feet of water.

No. 63.—Drilled well (191); depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 15 head of stock. Strata passed through: Soil; creamy clay; clay and rock.

No. 64.—Tubular well (190); depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump with 10-foot wheel; is

used for domestic supply and for 100 head of stock. Strata: Soil, 3 feet; white creamy clay, 15 feet; sand in streaks with cemented sand; sand with the water. A well less than half a mile north in a Beaver draw gets water at 110 feet.

No. 65.—Drilled well; depth of water does not vary; water obtained from the well by continual pumping; can not be easily lowered; quality of water, rather soft; water raised by wind pump with 12-foot wheel; is used for domestic supply, for 150 head of stock, and for irrigating one-half an acre. Strata passed through: Soil, 2 feet; creamy clay, 30 feet; magnesia; coarse gravel with the water; no rock; a weak vein of water higher up. This well is north of the Sappa. On the south side of the Sappa the Tertiary grit crops out.

No. 66.—Bored well (184); depth of water does not vary; can not be easily lowered; quality of water, medium hard; water raised by wind pump with 18-foot wheel; is used as a public well, and irrigates court-house yard. Strata passed through: Soil, 2 feet; yellow clay, 90 feet; sand and dry gravel.

No. 67.—Bored well (183); depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump; is used for domestic supply and for 15 head of stock. Strata: Soil, 5 feet; yellow soil; rock; gravel.

No. 68.—Dug well (182); depth of water does not vary; can be easily lowered; quality of water, soft; water raised by hand pump; is used for domestic supply and for 15 head of stock, Strata passed through: Soil; yellow clay and sand; magnesia gravel with water. This well is in a bottom, about 20 feet above the bed of one of the Beavers.

No. 69.—Drilled well (181); depth of water does not vary; 600 gallons per hour; mill will drain it in 2 hours, but the level of the water is restored in 20 minutes; quality of water, medium soft, but is becoming softer the longer it is used; water raised by wind pump; is used for domestic supply, for 100 head of stock, and for irrigating a small garden. Strata passed through: Soil; yellow clay; rock; sandy clay.

No. 70.—Drilled well; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump with 10-foot wheel; is used for domestic supply and for 100 head of stock. Strata passed through: Soil; yellow clay; rock. A well 1 mile south, with surface at about the same altitude, is 180 feet deep.

No. 71.—Drilled well (207); depth of the water does not vary; can not be easily lowered; quality of water, rather hard; water raised by wind pump with 10-foot wheel; is used for domestic supply, for 100 head of stock, and for irrigating a small area. Strata passed through: Soil, 1 foot; creamy clay, 20 feet; sand; sandstone, 4 feet; sand; sand and limestone, 6 inches; sand to bottom; water in quicksand.

No. 72.—Bored well (240); depth of water does not vary; can not be easily lowered; quality of water, rather hard; water raised by wind pump with 8-foot wheel; is used for domestic supply and for 95 head of stock. Strata passed through: Soil, 2 feet; creamy soil; rock and gravel with water.

No. 73.—Dug well (239); depth of water does not vary; can be easily lowered slightly—should be made deeper; quality of water, soft; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 25 head of stock. Strata passed through: Soil, 4 feet; creamy yellow soil, 41 feet; sand, 5 feet; rock and magnesia 12 feet; sand, 38 feet; magnesia, 2 feet; coarse sand and quicksand at water.

No. 74.—Dug well (208); depth of water does not vary; sufficient water obtained to supply 4 farms, besides travelers; can not be easily lowered; quality of water, soft; water raised by wind pump with 10-foot wheel; water used for domestic supply, as above, and 150 head of stock. Strata passed through: Soil, 3 feet; creamy soil, 30 feet; sand and gravel to bottom. This well is at Griswold post-office, 4 miles south of No. 93. A. J. McKinney's well, 3 miles east of Griswold, is 105 feet deep, with 5 feet of water. Four miles farther east is a well 90 feet to water.

No. 75.—Drilled well; depth of water does not vary; water obtained from the well fills a tank 17 by 29 by 2 feet in 36 hours, besides supplying stock; can not be

easily lowered; quality of water, soft; water raised by wind pump; is used for domestic supply, for 35 head of stock, and for irrigating 1½ acres. Strata passed through: Soil, 2 feet; creamy yellow soil; magnesia; sand with water. A well one-quarter of a mile north is 170 feet deep, with water at 100 feet. Wells 1 mile east are plentifully supplied with water.

No. 77.—Bored well; depth of water does not vary; can be easily lowered, on account of bad curbing; quality of water, soft; water raised by wind pump with 8-foot wheel; is used for public purposes. Strata passed through: Soil, 2 feet; creamy soil, 13 feet; gravel and sand. There are 5 wells on the town site, all having about the same depth; one is the Rock Island Railway well, 147 feet deep, apparently inexhaustible. A steam pump fills the 1,600-barrel tank in 11 hours.

No. 78.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, rather hard; water raised by wind pump with 12-foot wheel; is used for domestic supply and for 20 head of cattle. Strata passed through: Soil, 3½ feet; creamy soil, 10 feet; magnesia, red clay, and sand in layers, 80 feet; coarse gravel, 27 feet.

No. 79.—Drilled well (226); depth of water does not vary; can not be easily lowered; quality of water, soft.

No. 80.—Depth of water does not vary; can not be easily lowered (227). Soil; magnesia.

No. 81.—Bored well (228); depth of water does not vary; can be slightly lowered; water raised by wind pump with 8-foot wheel; is used for domestic supply and for 20 head of stock. Strata passed through: Soil, 4 feet; creamy clay, 76 feet; sand and rock; magnesia and gravel.

No. 82.—Drilled well; depth of water does not vary; can not be easily lowered; water raised by wind pump; is used for domestic supply.

No. 83.—Bored well; depth of water does not vary; 75 barrels per day; can not be easily lowered; quality of water, medium hard; water raised by wind pump with 10-foot wheel; is used for domestic supply, for stock, and for irrigating one-half an acre. Strata passed through: Soil, 2½ feet; creamy dirt, 52½ feet; sand, gravel, and rock, 50 feet. A well 1 mile south in Beaver Valley is 59 feet deep, with 2½ feet of water.

No. 84.—Bored well (238); depth of water does not vary; can not be easily lowered; water raised by wind pump; is used for domestic supply, for hotel, for 100 head of stock, and for irrigating a garden. Temperature, 56° F. Strata passed through: Soil, 5 feet; creamy clay, 75 feet; sand; whitish clay; sand; magnesia; gravel. This well is in the town of Kanorado.

No. 85.—Bored well (193); depth of water does not vary; mill running often day and night; can not be easily lowered; quality of water, rather soft; water raised by wind pump; is used for domestic supply, for 25 head of stock, and for irrigating 1½ acres. Strata passed through: Soil, 2 feet; cream-colored loam nearly to water; magnesia and gravel at water. A well on the next section west is 75 feet to water, being on higher ground.

No. 86.—Bored well; depth of water does not vary; can be lowered at times; quality of water, soft; water raised by wind pump; is used for domestic supply and for 10 head of stock. Strata passed through: Soil; creamy clay and fine gravel.

No. 87.—The water-bearing stratum was pierced only 4 feet, and the water rose 26 feet; depth of water does not vary; water raised by wind pump; is used for 300 to 400 head of stock and by travelers. This well is only 2 or 3 feet above the railway level at the depot.

No. 88.—Bored well; depth of water does not vary; can not be easily lowered; water raised by wind pump; is used for domestic supply, for stock, and for irrigating 1 acre, for which there is a pool supplied by the well.

No. 89.—Bored well; depth of water does not vary; can not be easily lowered; water used for domestic supply and for 30 head of stock. Strata passed through: Soil yellow clay, etc.

No. 90.—Tubular well; depth of water does not vary; can not be easily lowered; quality of water, medium hard; water raised by wind pump with 10 foot wheel; is used for domestic supply and for 10 head of stock. Strata passed through: Soil, 3 feet; yellow clay; some rock; gravel with water. A well on section 2 is 170 feet deep.

No. 91.—Another well on the same section is 156 feet to water. A well 1 mile north is 192 feet deep, with 10 feet of water. These are on a high promontory, at the beginning of the descent to the Republican River.

No. 92.—This well is on the south bank of a Beaver, about 15 feet above the bed. The prairie south is considerably higher. At a distance of one-half mile northeast is an outcrop of the magnesia at a higher level, but the breaks all around, both higher and lower, are the plains marl.

No. 93.—Bored well (188); depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump; is used for domestic supply and for stock. Strata passed through: Soil, 2 feet; creamy subsoil; rock; gravel with water.

No. 94.—Dug 146 feet and bored 35 feet; depth of water does not vary; can not be easily lowered; water raised by wind pump with 16-foot wheel; is to be used for irrigating 10 acres (185). Strata passed through: Soil, 3½ feet; creamy subsoil, 40 feet; flinty rock, 4 feet; sand, 23 feet; hard clay, 15 feet; sand, 16 feet; sand rock, 6 feet; clay and sand, 40 feet to water.

No. 95.—Bored well; depth of water does not vary; 60 barrels in 4 hours; can not be easily lowered; quality of water, rather hard; water raised by wind pump with 8-foot wheel; is used for domestic supply and for 300 head of stock. Strata passed through: Soil, 3 feet; cream-colored clay, 23 feet; white magnesia, 4 feet; sand rock, 1 foot; sand, 8 feet; rock, 4 feet; sand and rock, 65 feet; water in clay and sand.

No. 96.—Dug well; depth of water does not vary; can not be easily lowered; quality of water, rather soft; water raised by pulley and buckets; is used for domestic supply and for 12 head of stock. Strata passed through: Soil, 2 feet; cream soil, 18 feet; yellow sand and magnesia, 41 feet; gravel with water, 4 feet. A well one-half mile north is 58 feet deep.

No. 97.—Dug well (259); depth of water does not vary; can not now be easily lowered. The well has recently been made deeper; prior to its deepening the water level could be lowered. Water raised by wind pump with 8-foot wheel; is used for domestic supply, for 50 head of stock, and for irrigating a small area, which is being increased. Temperature, 54° F. Strata passed through: Soil, 5 feet; creamy soil, 30 feet; soapstone (?), 5 feet; sand rock, 36 feet.

No. 98.—Dug well; depth of water does not vary; can be exhausted in 2 hours with a good wind, but refills in 30 minutes; water raised by wind pump with 10-foot wheel; is used for domestic supply, for 50 to 70 head of stock, and for irrigating a small area. Strata passed through: Soil, 5 feet; creamy soil, 75 feet; hard conglomerate, 18 feet; sandstone; sand with water. Spurlock's well, on section 22, on the breaks of Lake Creek, 60 feet deep, with 1½ feet of water, irrigates 2 acres during winter.

No. 99.—Dug and bored well; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump with 10-foot wheel; is used for irrigation; tank, 85 by 45 by 5 feet. Strata passed through: Soil, 15 feet; clay, 6 feet; sand and gravel to bottom.

No. 100.—Dug and bored well; can not be easily lowered; water raised by wind pump with 12-foot wheel; is used for irrigation. Strata passed through: Soil, 28 feet; sand and gravel below; stopped at blue clay (shale?).

No. 101.—Dug and bored well; depth of water does not vary; can not be easily lowered; quality of water, medium hard; water raised by wind pump with 12-foot wheel; is used for irrigation. Strata passed through: Soil; sandy soil; streaks of sand; gravel and sand in water.

No. 102.—Dug well; depth of water does not vary; can not be easily lowered; quality of water, hard; water raised by wind pump with 8-foot wheel; is used for domestic supply and for 80 head of stock. Strata passed through: Soil and creamy subsoil, 20 feet; sand, 4 feet; shale below. This well is on the bottom of a branch of Goose Creek. A well at the house at 30 feet higher level got no water, after passing through these strata: Marl, 30 feet; sand, 4 feet; shale, 4 feet; shale, 30 feet. Rocky magnesia (Tertiary grit) crops out on the south side of the valley 50 feet above the level of No. 102.

No. 103.—Dug well, but has a tube 8 inches in diameter; water struck at 14 feet and rose 4 feet; depth of water does not vary; 650 gallons in 1 hour; can not be easily lowered; quality of water, hard; water raised by wind pump with 8-foot wheel; is used for domestic supply, for 40 head of stock, and one-half acre irrigated. Strata passed through: Soil, 1 foot; black earth, 7 feet; joint clay, 16 feet; sand to bottom; reached shale at 27 feet.

No. 104.—Dug well; depth of water does not vary, though heavy rains slightly raise the level; can not be easily lowered; quality of water, medium soft; water raised by pulley and buckets; is used for domestic supply and for 8 head of horses. Strata passed through: Soil, 2 feet; creamy clay, 14 feet; sand; coarse gravel at water.

No. 105.—Dug well; water was struck at 50 feet and rose 5 feet, where it has remained; depth of water does not vary; can not be easily lowered; quality of water, hard; water raised by pulley and buckets; is used for domestic supply and for 12 head of stock. Strata passed through: Soil, 1½ feet; gray soil (creamy), 10 feet; reddish clay and gravel, with streaks of sand, 35 feet; coarse sand gravel, 2 feet; reddish, putty-like clay at water; gravel below.

No. 106.—Dug well; water rose a little when first struck; depth of water does not vary; can not be easily lowered; water raised by wind pump with 10-foot wheel; is used for domestic supply and for irrigating three acres; tank, 65 by 30 by 4 feet. Strata passed through: Soil, 1 foot; cream-colored soil, 19 feet; sand; joint clay and coarse sand, 7 feet. This well is in Eagletail Valley at Sharon Springs. Mr. Ericson has another well between Eagletail and a northern draw, and a reservoir 50 by 100 feet. The water level this year is lower in the wells than formerly, and a water elevator here was found too short.

No. 107.—Dug well; depth of water does not vary; can not be easily lowered except by the running in of sand; quality of water, soft; water raised by pulley and buckets; is used for domestic supply and for 15 head of stock. Strata passed through: Sandy alluvia. This well is on the second bottom of the South Fork of the Smoky Hill River, east of Sharon Springs, on the right bank of the river.

No. 108.—Dug well; flow increased slightly at first, but sand gets in and clogs it; depth of water does not vary; can not be easily lowered; quality of water, rather hard; water raised by hand pump; has also a "Jumbo" wind wheel; is used for domestic supply and for several head of stock. Strata passed through: Soil, 10 feet; sand to water.

No. 109.—Bored well; water was struck at 129 feet and rose 6 feet; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by hand pump; is used for domestic supply and for several head of stock. Strata passed through: Soil, 3 feet; creamy soil, 14 feet; rock (red) to water. Rock crops out in a ravine one-fourth of a mile east.

No. 110.—Dug well; depth of the water varies by rising slightly in the spring of the year; can be easily lowered, but is very soon replenished; quality of water, rather soft; water raised by pulley and buckets; is used for domestic supply and for 4 head of stock. Strata passed through: Soil, 1 foot; creamy clay, 14 feet; streak of sand; creamy clay, 6 feet. The bottom of the well is in soapstone (shale), and water is from the gravel. Another well, somewhat lower in the draw, has water at the same depth, and another still lower has water at 16 feet.

No. 111.—Dug well; depth of water does not vary; can not be easily lowered; quality of water, medium hard; water raised by wind pump with 16-foot wheel; is used for town supply and is very abundant. Strata passed through: Soil, 5 feet; yellow creamy soil, 25 feet; sand and gravel, 5 feet. This well is in the valley of Eagletail Creek, within the city limits of Sharon Springs. Wells in the higher part of the town have little or no water.

No. 112.—Dug well (258). Strata passed through: Soil, 2 feet; cream-colored clay, 28 feet; shale; no water. Mr. Garsuck has made several wells, but always with the same result, reaching the shale without the water-bearing gravel at 25 to 30 feet.

No. 113.—Driven well; depth of water does not vary; can not easily be lowered; quality of water, medium hard; is used for domestic supply and for stock. Strata passed through: Soil, with streaks of clay and sand, 6 feet; sand and gravel to bottom; quicksand at bottom. This well is in the South Smoky Hill bottom. Mr. Allman has two other wells near, watering 60 head of stock, and there are four others on the bottom between here and Yost's (No. 98), all having an abundance of water. Mr. Allman irrigates from a stream.

No. 114.—Dug well; depth of water does not vary; can not be easily lowered; quality of water, rather soft; water raised by hand pump; is used for domestic supply. Strata passed through: Sandy alluvia, shale at bottom. It is on the second bottom of the South Fork of the Smoky Hill River, which has pools connected by running streams which disappear in the sands farther east. There are also springs on the banks running off the shale, which crops in ravines, under the Tertiary beds.

No. 115.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, soft; water raised by wind pump with 8-foot wheel; is used for domestic supply, for 15 head of stock, and for irrigating one-quarter of an acre. Strata passed through: Soil, 5 feet; creamy soil, 15 feet; magnesia, rock, and sand; gravel with water, 18 feet. Two wells on Weskan town site are 148 feet deep. A well on section 28, 157 feet deep, has 15 feet of water, and has rock at about the same level as No. 115.

No. 116.—Dug well; depth of water does not vary; can be lowered slightly; quality of water, soft; water raised by steam pump; is used for railway purposes. This well is on rather lower ground than No. 115, from which it is distant about 1 mile.

No. 117.—Dug well; depth of water does not vary; can not be easily lowered; quality of water, rather hard; water raised by hand pump; is used for domestic supply. Strata passed through: Soil; cream-colored subsoil; water in gravel and sand.

No. 118.—Bored well; depth of water does not vary; can not be easily lowered; quality of water, medium hard; water raised by pulley and bucket; is used for a schoolhouse. Strata passed through: Soil, 3 feet; creamy clay, 23 feet; magnesia, 4 feet; running gravel, 16 feet; rock and sand to bottom. This well is on nearly the highest land in Kansas.

No. 119.—This well is in a bed of a branch of Goose Creek.

No. 120.—Bored well. The water was reached at 68 feet, and rose 15 feet. It has slightly affected the water of No. 97, which is on the same section. Strata passed through: Soil, 6 feet; creamy soil, 20 feet; sand, 15 feet; soapstone (?), 3 feet; hard clay (magnesia red clay?), 24 feet.

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UNITED STATES

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No. 132

THE DISSEMINATED LEAD ORES OF SOUTHEASTERN MISSOURI.—WINSLOW

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On March 2, 1895, the following provision was included in an act of Congress:

"*Provided*, That hereafter the report of the mineral resources of the United States shall be issued as a part of the report of the Director of the Geological Survey."

In compliance with this legislation, the report Mineral Resources of the United States for the Calendar Year 1894 forms Parts III and IV of the Sixteenth Annual Report of the Survey.

The money received from the sale of these publications is deposited in the Treasury, and the Secretary of the Treasury declines to receive bank checks, drafts, or postage stamps; all remittances, therefore, must be by POSTAL NOTE or MONEY ORDER, made payable to the Director of the U. S. Geological Survey, or in CURRENCY, for the exact amount. Correspondence relating to the publications of the Survey should be addressed

TO THE DIRECTOR OF THE
UNITED STATES GEOLOGICAL SURVEY,
WASHINGTON, D. C.

WASHINGTON, D. C., *January, 1896.*

DEPARTMENT OF THE INTERIOR

BULLETIN

OF THE

UNITED STATES

GEOLOGICAL SURVEY

No. 132



WASHINGTON
GOVERNMENT PRINTING OFFICE
1896

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

THE DISSEMINATED LEAD ORES OF SOUTHEASTERN MISSOURI

BY

ARTHUR WINSLOW



WASHINGTON

GOVERNMENT PRINTING OFFICE

1896

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LETTER OF TRANSMITTAL.

ST. LOUIS, MO., *May 27, 1895.*

SIR: I have the honor to transmit herewith my report on the disseminated lead ores of southeastern Missouri.

The results contained in this report are the product of investigations conducted during the past three months. These investigations were in extension of the work on which was based my report, as State geologist of Missouri, on the lead and zinc deposits of the whole State. The principal contributions which the present report makes to our knowledge of the district relate to the structure and the general areal geology. The outlines of the formations as represented on the map have never before been defined, and the structure as recorded in the drill-hole results and expressed in the cross-sections has never before been presented. In addition, the most recent progress in mining is recorded, and the general distribution of the ore as revealed by drilling is outlined.

In order, however, that the report may stand by itself as a short treatise on this important lead district, I have not restricted myself to the mere presentation of that which is new, but have rounded this out with brief descriptions abstracted from my recently published report above referred to. Much local detail there included, however, is here omitted, and for such supplementary matter the reader is referred to that report.

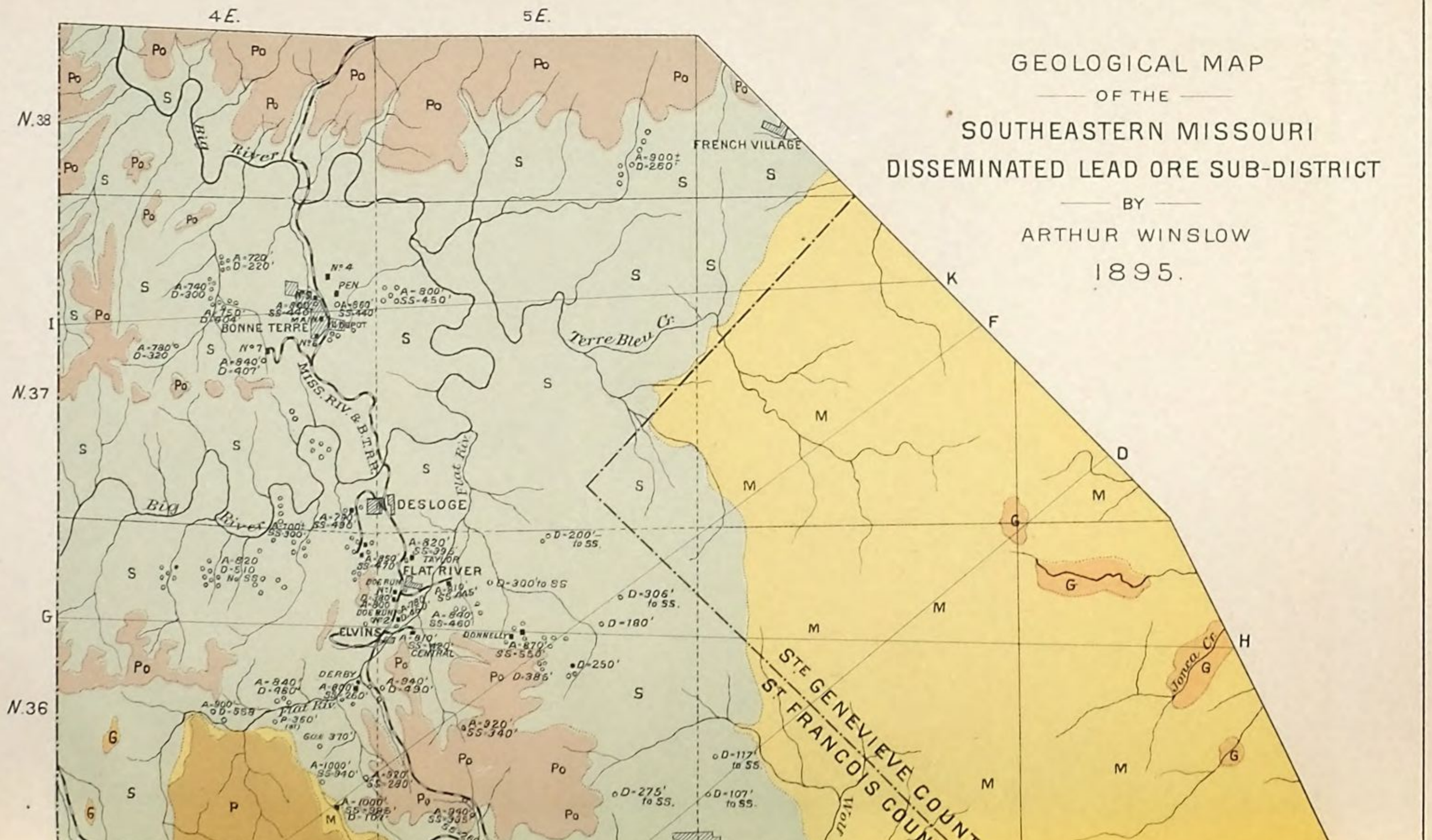
In conclusion, I desire to express my indebtedness for assistance in the prosecution of the work, and for information contributed, to Mr. Arthur Thacher, superintendent of the Central mine; Mr. O. M. Bilharz, assistant superintendent of the Doe Run mines; Mr. Frank Schulte, of Fredericktown; Mr. George J. Cole, secretary of the Derby Lead Company; Mr. D. Bauman, of Farmington; and ex-Governor H. C. Brockmeyer, of St. Louis.

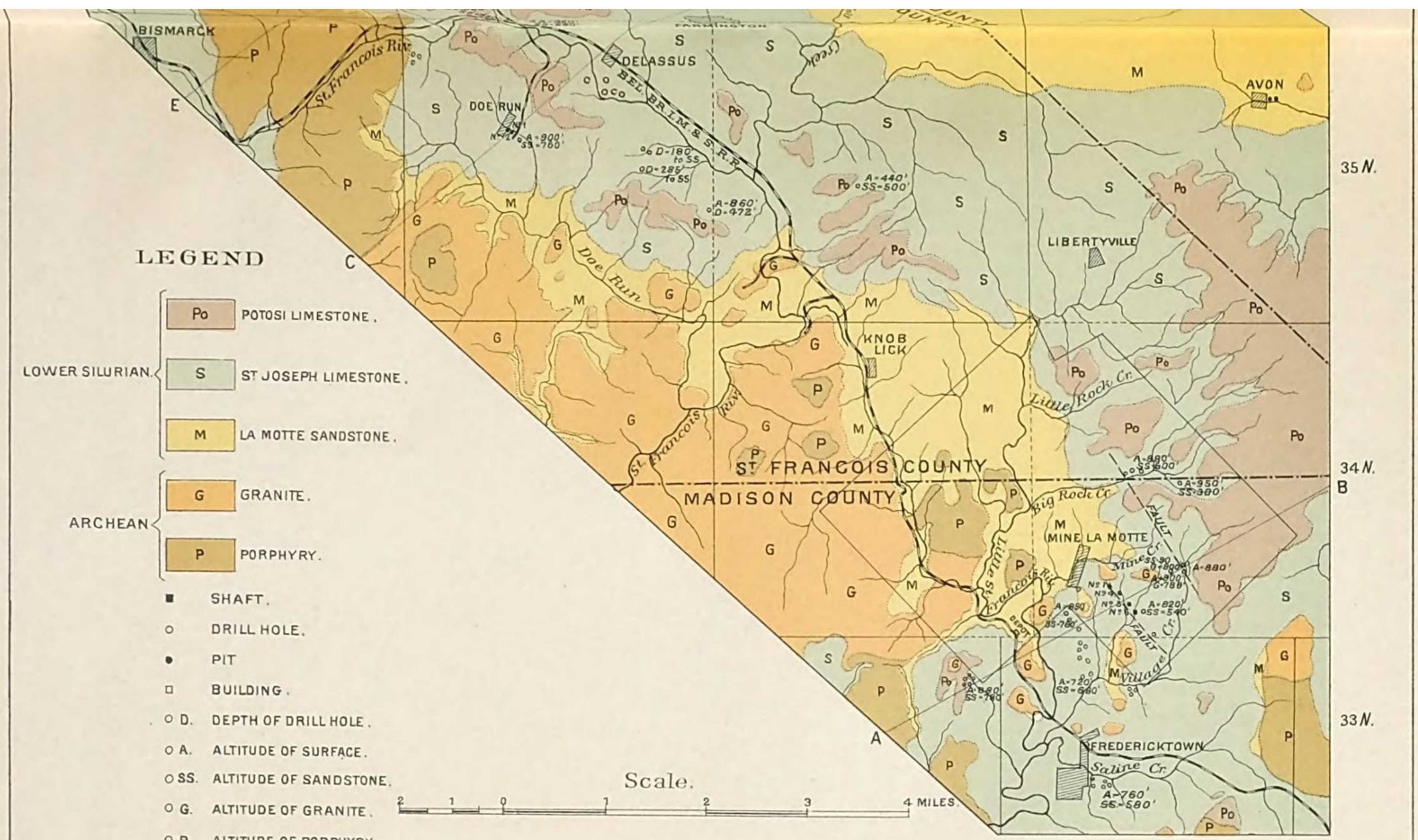
Very respectfully, your obedient servant,

ARTHUR WINSLOW.

Hon. CHARLES D. WALCOTT,
Director United States Geological Survey.

GEOLOGICAL MAP
OF THE
SOUTHEASTERN MISSOURI
DISSEMINATED LEAD ORE SUB-DISTRICT
BY
ARTHUR WINSLOW
1895.





Lith. A. Hoen & Co. Baltimore.

THE DISSEMINATED LEAD ORES OF SOUTHEASTERN MISSOURI.

By Arthur Winslow.

LOCATION AND AREA.

The disseminated lead ores of Missouri are encountered within 60 miles south of St. Louis and within 25 miles west of the Mississippi River. They belong to the southeastern lead and zinc district of the State. The area in which these ores have been developed is about 35 miles long in a northerly-southerly direction and about 25 miles broad from east to west; it lies principally in St. François County, but the northern portion of Madison County and a little of eastern St. Genevieve County are included. Only 13 mines have been opened in these ores; the mines are somewhat widely separated, and may be grouped into four camps, as follows:

At Bonne Terre: The St. Joseph Lead Company's mine, five separate openings.

In the Flat River camp: The mine of the Desloge Consolidated Lead Company, including two openings; the Taylor mine of the Flat River Lead Company; the mines of the Doe Run Lead Company, including two openings; the mine of the Central Lead Company; the Crawley shaft of the St. Joseph Lead Company; the Donnelly Lead Company's mine; the Leadington Lead Company's mine; and the Derby Lead Company's shaft, which is now being sunk.

At Doe Run: The Doe Run Lead Company's mine.

At Mine La Motte: The mine of the Mine La Motte estate, four separate openings.

In addition, the diggings at Avon may be included.

Other ore bodies have been exploited by drilling, and numerous occurrences of sparsely disseminated ores have been revealed, but there are also great areas which are practically barren.

HISTORY OF MINING.

Lead mining in southeastern Missouri has been in progress nearly two hundred years, beginning about 1720. But the mining of disseminated ores on the scale now seen is of recent date, beginning scarcely thirty years ago. It is true that before the middle of the eighteenth century disseminated lead ores were dug at Mine La Motte, but they were difficult to work and smelt, and preference was given to the massive galena found in surface clays and in crevices in the rock. Featherstonhaugh[1] describes the quarrying here of disseminated ore

[1] Geological Report of the Examination made in 1834 of the Elevated Country between the Missouri and Red Rivers, Washington, 1835.

in 1836. Up to 1878, however, the mining of this deposit was crude and interrupted, the excavations consisting of pits in the loose surface materials or of shallow shafts sunk to strike the ore in the rock immediately beneath the surface.

Austin, in 1804, refers to a find of galena in small particles in a soft gray limestone on Big River. At the Avon mines work was begun about 1848, and was sustained for a few years. After a long intermission operations were resumed in 1874, but the mine was soon after finally abandoned. The whole output is reported to have amounted to about 1,200 tons of ore. Shortly before the war, at the site of Bonne Terre, Francis LaGrave found, with a churn drill, disseminated lead ore at a depth of 80 feet.

But the beginning of the present mining era was essentially post-bellum. In 1864 the St. Joseph Lead Company acquired possession of its Bonne Terre lands and began preparations for systematic mining. During the first few years there were many obstacles to overcome, and the production up to 1870 did not amount to much over 1,200 tons of lead. The diamond drill was introduced here in 1869 and did much to advance operations. By 1874 the annual output had reached 1,300 tons of lead, and many improvements had been made. Now the annual production of this company is nearly 15,000 tons of lead; a large concentrating plant with a capacity of 1,000 tons of rock per twenty-four hours is in operation, together with smelting works at Herculaneum, a supplementary railway 50 miles long, and other incidental establishments.

At Mine La Motte systematic work was begun after 1878; deep shafts were sunk, and since then a concentrating mill and furnaces have been erected. About one-third of the total output has been mined since that date.

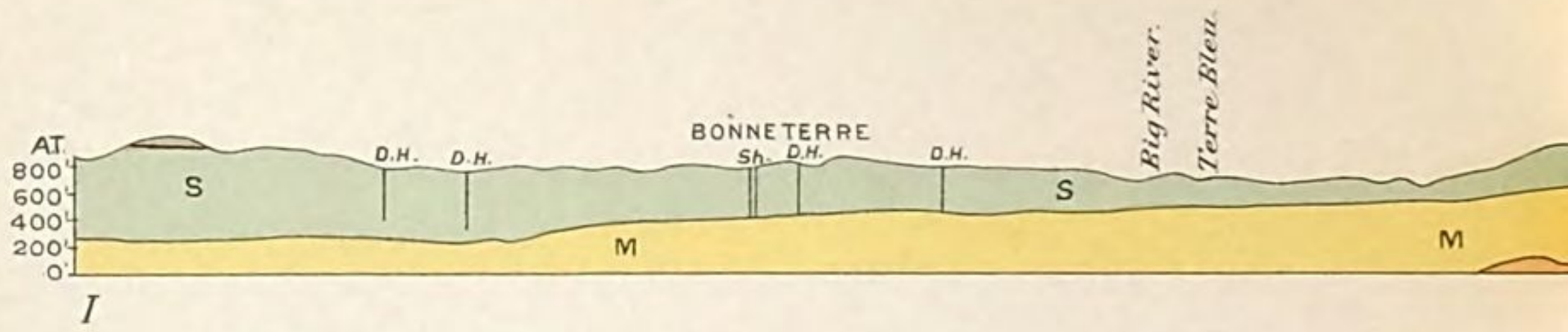
The Doe Run deposit was the next in order of development; but the first prospect shaft was not sunk there until 1885. Within two or three years after that date the mine was opened and the mill and furnaces were erected.

The Flat River mines were the last opened in disseminated ores. Most of the diamond drilling has been done since 1888, and there was no deep shaft operating these ores before 1890, though a large number had been sunk for crevice mineral, and on the present Desloge property the old Bogy shaft, sunk in the early seventies, reached a depth of about 220 feet. Practically all of the developments of this camp have, therefore, been made during the last five years.

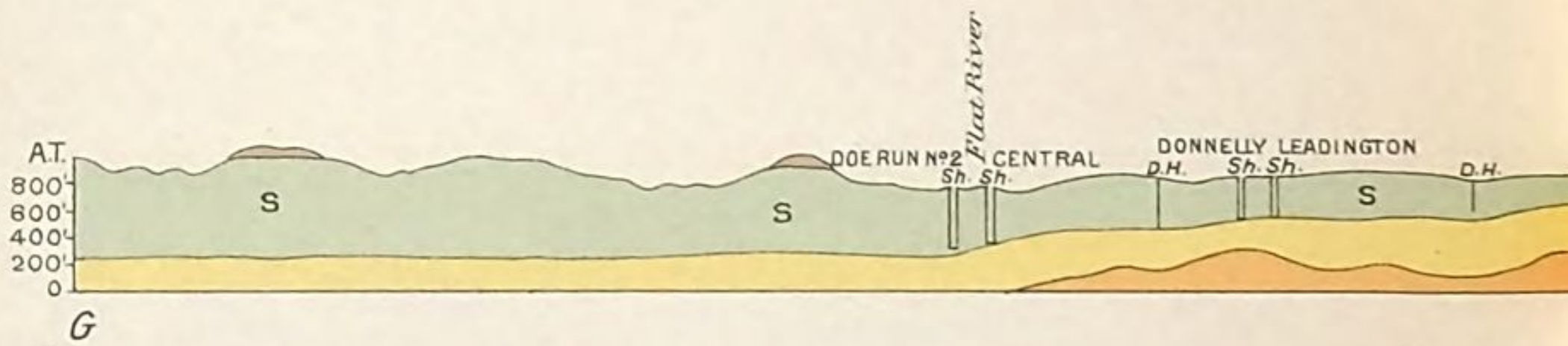
TOPOGRAPHY.

The topography of the country in which the disseminated lead ores are found is hilly, but not mountainous. The writer has described it as intermediate between the highland type of the Archean area which flanks it on the southwest and the plateau type which prevails in south-

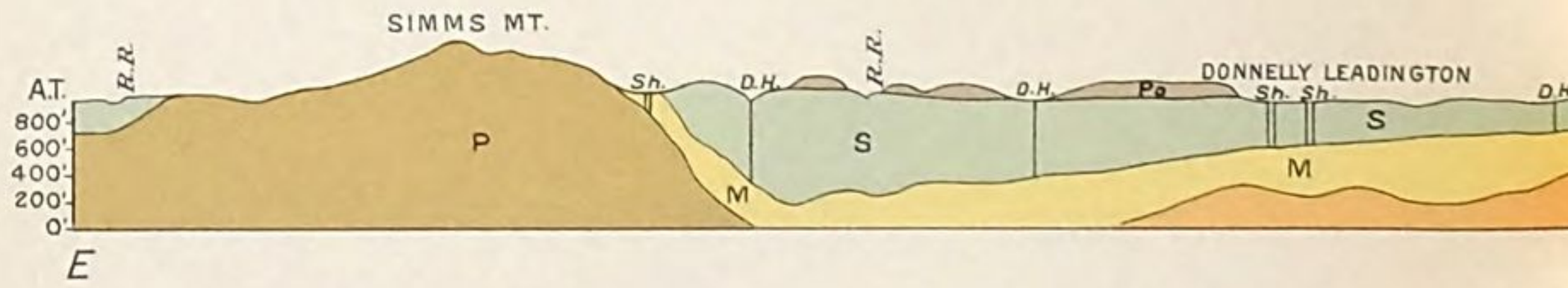
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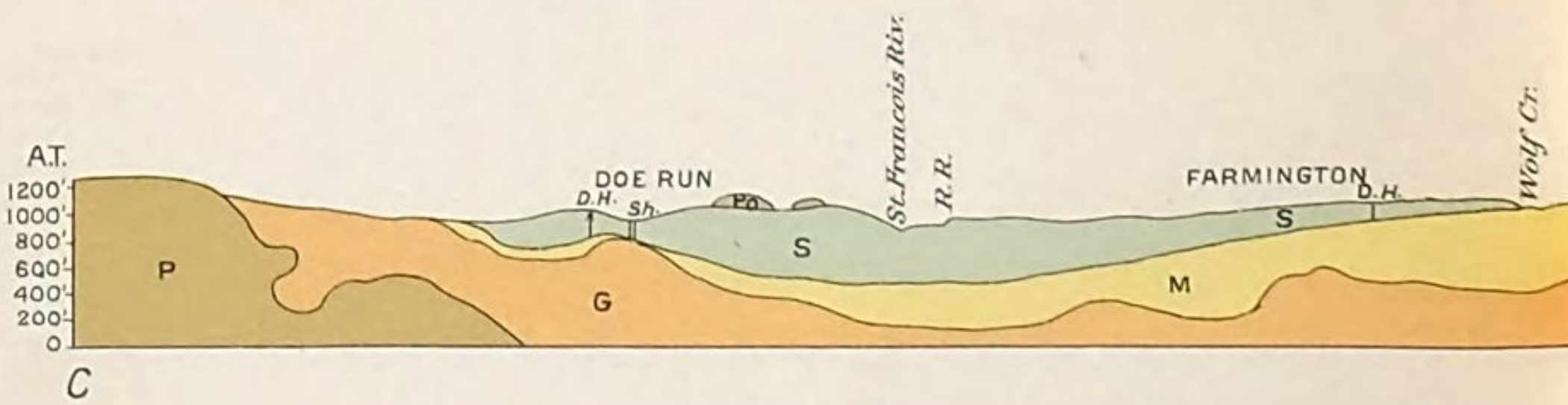
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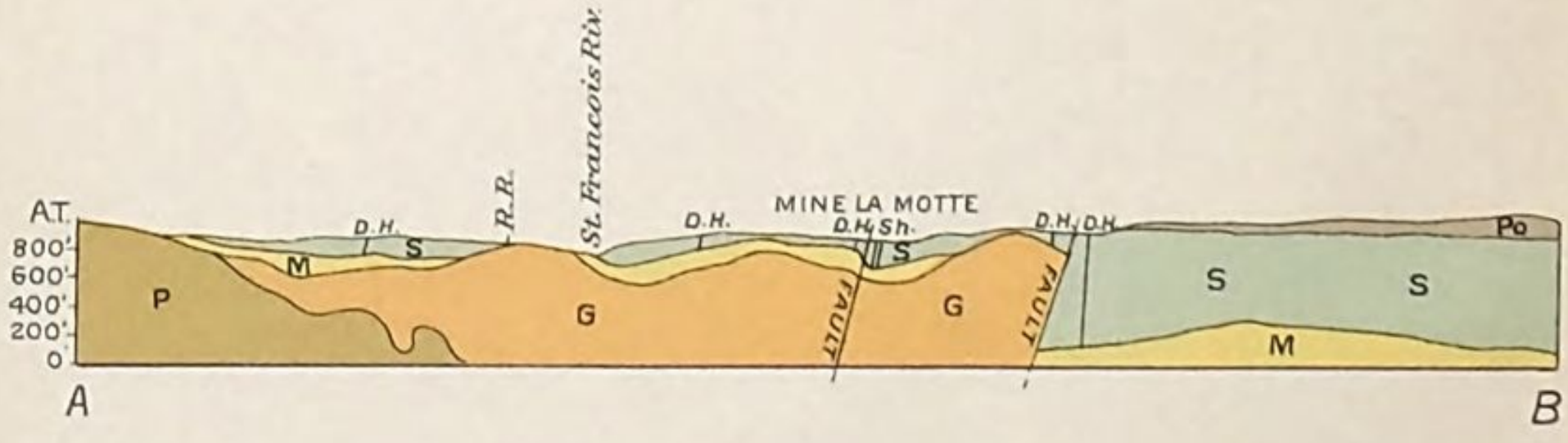
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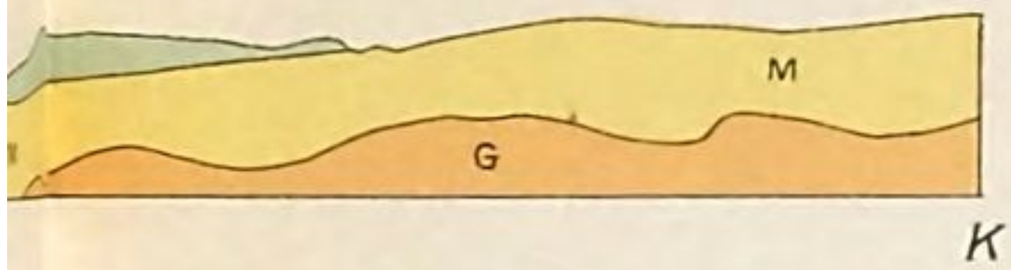


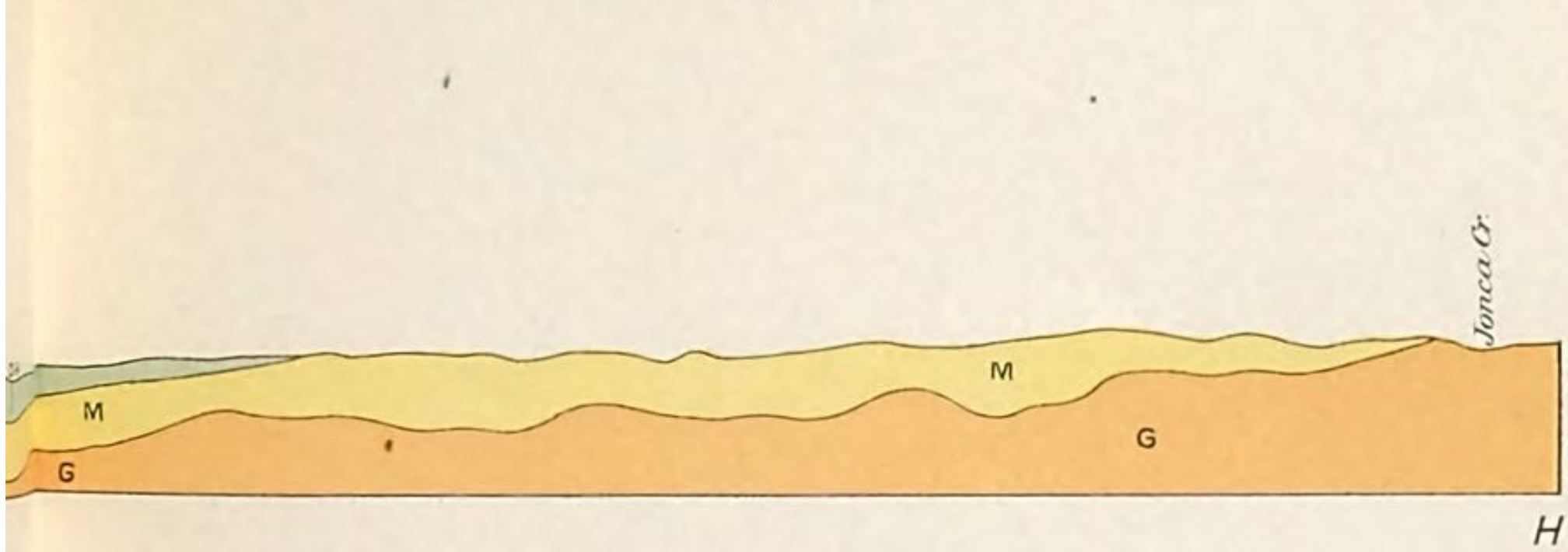
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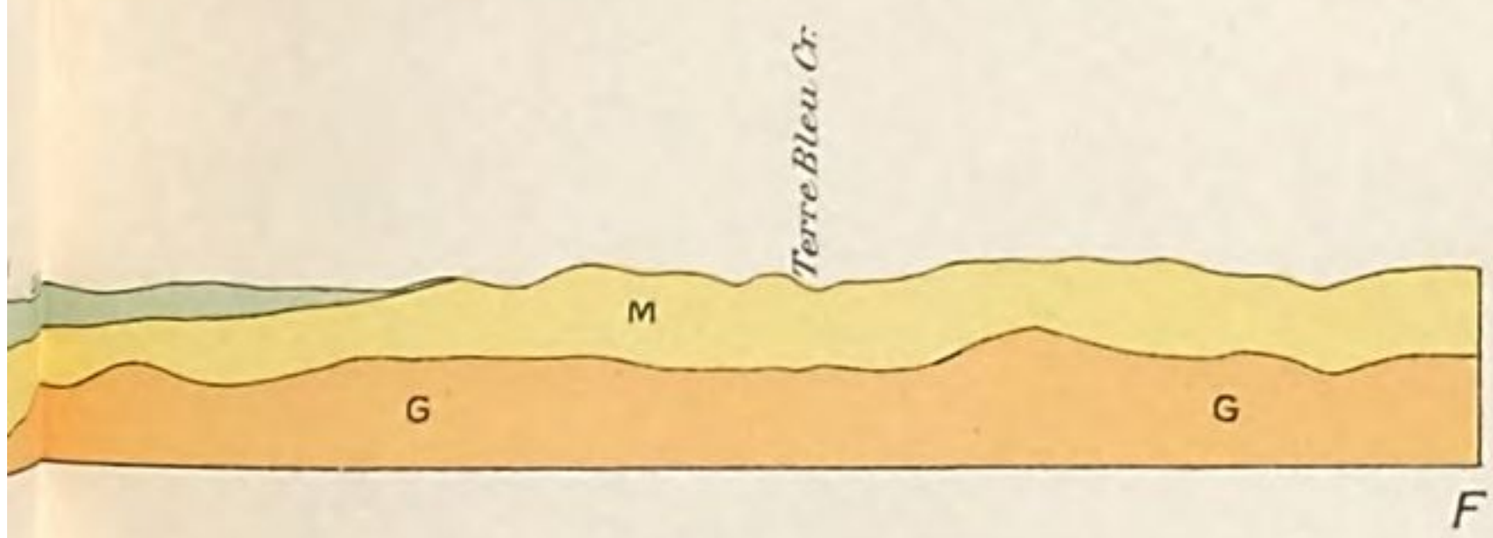


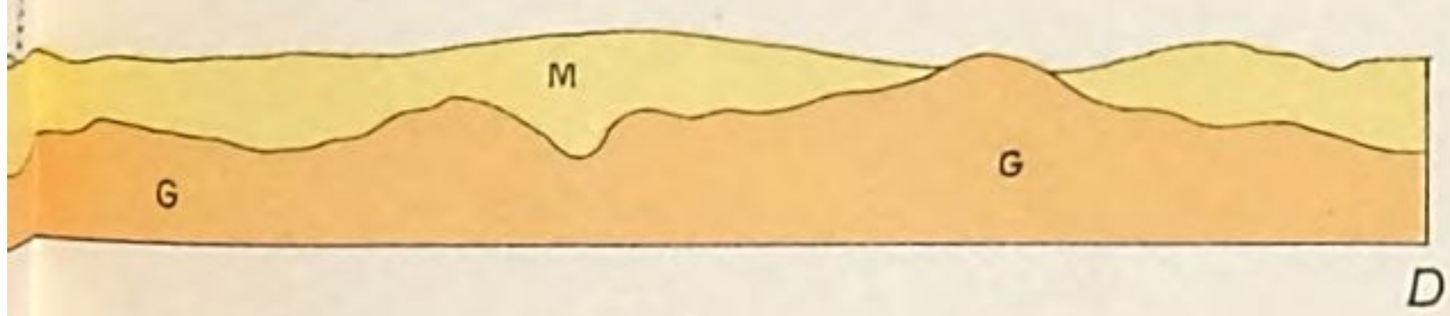
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LEGEND.

- POTOSI LIMESTONE. Po — LOWER SILURIAN.
- ST JOSEPH LIMESTONE. S — LOWER SILURIAN.
- LA MOTTE LIMESTONE. M — LOWER SILURIAN.
- GRANITE. G — ARCHEAN.
- PORPHYRY P — ARCHEAN.

CROSS SECTIONS

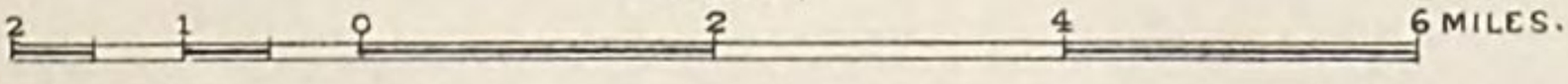
TO ACCOMPANY

GEOLOGICAL MAP OF SOUTHEASTERN MISSOURI

BY

ARTHUR WINSLOW

Scale.



Lith. A. Hoen & Co. Baltimore.

western Missouri, where there are deep valleys between flat uplands or long, level-crested ridges. Occurring in a country of nearly horizontal strata, the forms and distribution of the features of relief have no marked relation to geologic structure; they are of irregular distribution and of widely varying shapes and dimensions. The extremes of altitude, excluding the Archean hills, are 1,200 and 600 feet above tide, while locally the tops of the hills are generally not more than 200 feet above the valleys.

The hills are mostly covered with timber, principally oaks, of medium or small size and of little value except for local uses.

The larger streams have narrow flood-plains which are cultivated, but the farming lands are generally over the minor hills and slopes lying between the streams and the summits.

STRATIGRAPHY AND LITHOLOGY.

The rocks of this portion of southeastern Missouri belong to the following formations:

Lower Silurian	Potosi limestone.
	St. Joseph limestone.
	La Motte sandstone.
	Iron Mountain conglomerate.
Archean	Granites and porphyries.

The distribution of these formations is shown on the accompanying geological map (Pl. I). The clastic rocks are placed in the Lower Silurian for reasons given in detail in the writer's recent report on the lead and zinc deposits of Missouri.[1] The possibility still remains that there may be a faunal break which will admit of some of the lower strata being classed as Cambrian, though there is nothing in the stratigraphy to suggest it. This must, therefore, be left to the paleontologists, and owing to the great dearth of fossils the problem is not an easy one for them to solve.

ARCHEAN.

The Archean rocks undoubtedly underlie the whole country, but they crop out within the mining area only in the vicinity of Mine La Motte. Southwest of that mine is the border of the main Archean area of the State, as shown on the map. Outliers are found on the eastern margin of the area mapped, in St. Genevieve County, but these are really beyond the limits of the disseminated ores as here defined. We have, hence, little to do with these rocks; their connection with the ore deposits is of but a general nature. The only localities where they are in close association are at Mine La Motte and at Doe Run.

The porphyries are generally red or brown, and are composed principally of quartz and feldspar, with small grains of iron oxide scattered through the ground-mass. The texture is fine-grained and homogeneous, and, under the microscope, is holocrystalline; larger porphyritic crystals of quartz or feldspar occur scattered through the base. The wavy lines

[1] Missouri Geological Survey, Vol. VI, 1894, Lead and Zinc Deposits, Chap. IX.

known as "flowage structure" are also present. The rock is frequently brecciated, the fragments themselves being composed of porphyry.

The granites are mostly of a pink color. The constituent minerals are principally quartz and feldspar. Black mica occurs in a few places, but it is not evenly disseminated. Hornblende is very rarely found. In texture the granites frequently approach the porphyritic, the feldspar occurring as a ground-mass in which the quartz crystals are embedded. In other cases the constituent crystals of quartz and feldspar are clearly separable, and occur in nearly equal proportions.

Regarding the relations of the granites and porphyries, the conclusion has been reached by Mr. Haworth that they were "formed from the same or similar molten magmas, and that their differences in texture are probably due to their solidifying under different physical conditions, and, secondarily, to a slight lack of homogeneity in the magmas."

IRON MOUNTAIN CONGLOMERATE.

This formation, which derives its name from its development at Iron Mountain, in association with the iron ores, is of very irregular distribution, consisting of bowlders and large pebbles of Archean rocks occupying depressions and hollows in the old land surface. It is encountered underground in the workings at Doe Run; but it is often absent, the La Motte sandstone then resting directly on the crystallines. Outcrops have nowhere been observed within the area under consideration, and hence the formation is not shown on the map. Its thickness is very variable, attaining perhaps 50 or 100 feet in places, and from that dwindling down to nothing. In all probability the deposit never extended far from the shore-line. At Doe Run the bowlders and pebbles consist of granite and diabase, while the matrix is principally limestone, which often is very chloritic and contains disseminated galena. The rock lies in depressions of the granite floor or massed against steep walls.

LA MOTTE SANDSTONE.

This rock underlies nearly the entire area represented on the map, but is exposed only around the Archean outcrops—where it extends up the old hillslopes—and over the eastern portion, in St. Genevieve County, where the Farmington anticline brings it to the surface. In St. Genevieve County it was described by Shumard as the Second Sandstone, and, strange to say, was placed over the St. Joseph limestone to the west, which was classed as Third Magnesian.[1] Preconceived ideas probably prejudiced observation, and further, as the field work was in St. Genevieve County and proceeded from east to west, the sections best displaying the relations of these formations were probably not examined. Had the geology of St. François County been carefully studied the mistake could not have been made.

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[1] Report Missouri Geologial Survey, 1855–1871, p. 299.

The thickness of this formation within the mining area is very variable; it tapers out up the slopes of the old Archean hills, while in closely adjoining depressions it may be 200 feet thick. Thus, at Mine La Motte it has been drilled into to a depth of 250 feet and the bottom not reached. Near the southeastern end of Simms Mountain a shaft was sunk in it to a depth of 100 feet. These are both in proximity to Archean outcrops. The thickness away from such, in the larger basins, has not been determined. It probably amounts to as much as 400 feet, if not more.

The distribution of this sandstone was, apparently, largely determined by two conditions, i. e., the proximity of granite and the slope of the Archean floor. Porphyries have very little free quartz, and consequently sandstones are not readily derived from them. Granites abound in free quartz, and must be regarded as the principal sources of supply. Hence we find the La Motte sandstone in greatest abundance about the granite areas. Where the slopes from the old shore-line were steep sandstone sediments could not gather, but sank to the basins, and in such cases were completely covered by the later-formed limestones.

This sandstone generally occurs in thick, massive beds, though it is sometimes thinly bedded or flaggy near the top. It is usually composed of grains of quartz in a matrix of smaller quartz grains. Sometimes the matrix is limy, and at the top of the formation the rock grades into a sandy limestone, and beds of limestone alternate with beds of sandstone. Near the base it is often of coarse texture, containing layers of grit and small quartz pebbles; also decomposed porphyry and granite, and pebbles of those rocks when near Archean areas. It sometimes contains chlorite, but is never micaceous. It is usually soft and friable, and often false bedded. The color is generally yellow or reddish, sometimes white. The quartz grains are often enlarged secondarily, but not always.

The following are illustrative sections of this formation:

Record of drill hole No. 211, Mine La Motte.

	Feet.
1. Surface clay	13
2. Limestone, white, sandy	2
3. Sandstone, black, yellow, and white	10
4. Sandstone, white	12
5. Sandstone, yellow	28
6. Sandstone, white and yellow beds	178
7. Sandstone, pink	21
8. Sandstone, almost red	9
Total	273

Record of drill hole No. 51C, Bonne Terre.

	Feet.
1. Limestone, no core, drilled with a solid bit	277
2. Limestone, magnesian, coarse-textured, crystalline, with galena disseminated at intervals and also lining small cavities; a good deal of chlorite; no chert	60
3. Limestone, like above, more dense, highly chloritic, somewhat shaly; some galena	5

	Feet.
4. Shale, dark and drab colored; a little galena near the base	4
5. Limestone, magnesian	5
6. Limestone, sandy, very granular, pitted, highly chloritic; little galena, with pyrite disseminated in small grains	9
7. Sandstone, like the last, less chloritic, more sandy, containing not much more than enough lime to cement the grains together	8
8. Limestone and sandstone, consisting of alternations of sandy magnesian limestone and of limy sandstone; white and drab; in part coarse and granular, elsewhere dense and shaly, but always sandy; little chlorite; some pyrite at 411 feet; no galena; limestone less porous than higher up	86
9. Sandstone, brown to red, soft, friable; grains rounded and not enlarged secondarily; containing little or no lime, but with a matrix of very fine sand.	20
Total	474

Record of shaft at foot of Simms Mountain, middle of N W. ¼ sec. 36, T. 36 N., R. 4 E.

	Feet.
1. Soil and clay	5
2. Sandstone, yellow	2
3. Sandstone, blue	8
4. Sandstone, yellow	12
5. Sandstone, gray, with porphyry pebbles	3
6. Sandstone, blue	5
7. Sandstone, gray, with hard granite pebbles	10
8. Sandstone, white	20
9. Sandstone and conglomerate, with sandstone pebbles	7
10. Sandstone, white	22
11. Conglomerate, with granite or porphyry	1
12. Granite, red, with upper 9 feet soft, lower 3 feet hard	12
Total	107

Record of drill hole No. 9, Series II, Doe Run.

	Feet.
1. Surface clay	49
2. Limestone, gray	89
3. Sandstone	56
4. Limestone, gray	8
5. Sandstone	5
6. Decomposed granite and limestone	4
7. Granite, hard	5
Total	216

ST. JOSEPH LIMESTONE.

This formation also underlies the larger part of the area, and is the prevailing surface rock. Like the Mine La Motte sandstone, it also wedges out up the old hillslopes, and in shallow basins it is of much diminished thickness. Thus, just north of Knob Lick the Potosi limestone is almost, if not immediately, in contact with the La Motte sandstone, because of the nearness of the granite floor to the surface. At Mine La Motte the thickness from the sandstone to the overlying Potosi limestone is estimated to be about 200 feet, while around Flat

River and Bonne Terre it is somewhere near 600 feet, which is probably about the maximum.

This limestone occurs normally in massive beds, but it is sometimes thinly bedded and flaggy, especially near the base as exposed along the eastern edge of St. François County, and also in the upper part as exposed along Flat River. Shale beds are also included; such are encountered near the base of the section at Mine La Motte, near the base and top at Bonne Terre, and in the upper part along Flat River and southward to the St. François River. They seem at places to be quite widespread, and elsewhere very limited. They are of blue and greenish colors.

The texture of the St. Joseph limestone is normally granular, the rock consisting of closely compacted crystals of dolomite, sometimes mixed with calcite. It is often minutely vesicular, with dolomite crystals lining the cavities. Sometimes it is fine-grained. The color is light or dark gray, the latter particularly in the ore-bearing portions; on weathering, the rock often acquires a yellow color.

In composition it is a limestone with a large percentage of magnesia, though generally less than in a theoretical dolomite. It contains more or less silica, especially near the base, where grains of sand are visible and the rock grades into a sandstone. It also often contains much chlorite, in places sufficient to give the rock a decidedly green color. This mineral is especially abundant in the exposed lower beds of eastern St. François and of western St. Genevieve counties, and the drill cores show it to be prevalent in the basal beds along Flat River. No chert or drusy quartz is found in this formation.

Typical sections of this formation are as follows:

Record of drill hole No. 93, Mine La Motte.

	Feet.
1. Clay	8
2. Limestone, yellow	5
3. Limestone, gray	106
4. Limestone, gray, pink, white, and black alternating	64
5. Limestone, black	96
6. Slate and sand, dark	5
7. Limestone, gray	3
8. Sandstone, white	3
Total	290

Record of drill hole No. 530, Mine La Motte.

	Feet.
1. Clay	8
2. Limestone, lower part slaty	14
3. Limestone, black	44
4. Limestone, gray and white	8
5. Limestone, "Black," with galena	38
6. Limestone, gray and black	5
7. Limestone, "White," with galena	45
8. Sandstone	8
Total	170

Record of drill hole No. 46, Bonne Terre.

	Feet.
1. Soil and clay	9
2. Limestone, brown	51
3. Limestone, black	13
4. Limestone, with specks of galena	9
5. Limestone, yellow	14
6. Limestone, dark and light colored layers alternating	51
7. Limestone, black	10
8. Limestone, with a little galena	11
9. Limestone, with a seam of calcite	14
10. Limestone, with a little galena	10
11. Limestone, showing a seam of galena	9
12. Limestone, rich in galena	5
13. Limestone, with little galena	9
14. Limestone, dense, hard	42
15. Shale	15
16. Limestone, hard, white	10
17. Limestone, dark-colored and softer	36
18. Limestone, porous, much chlorite	1
19. Limestone, with disseminated galena	3
20. Limestone, a little galena and chlorite	30
21. Galena, rich	1
22. Limestone, little galena	18
23. Limestone, no galena, very green	32
24. Soft clay and brown rock	2
25. Limestone, very green, with white spots like marble	14
26. Sandstone	19
Total	441

Record of Rohan drill hole No. 2, Bonne Terre.

	Feet.
1. Limestone, shaly	17
2. Limestone, buff-colored	143
3. Limestone, grayish, some shale	140
4. Limestone, gray, shaly near bottom	93
5. Limestone, considerable chlorite	11
Total	404

Record of drill hole No. 2, Central Lead Company.

	Feet.
1. Surface clay	4
2. Limestone, yellow and variegated	106
3. Limestone, gray	55
4. Limestone, gray, with some specks of galena and 2 inches of richly disseminated ore at base	15
5. Limestone, gray, with small specks of galena	40
6. Limestone, gray, with galena in seams	126
7. Limestone, gray, with seams of shale and disseminated galena	8
8. Limestone, gray, with seams of shale, and rich in galena	2
9. Limestone, dark, coarse texture, rich in galena	14
10. Limestone, light color, coarse texture, some galena	4
11. Limestone, sandy, white, no galena	4
Total	378

Record of drill hole No. 1, on the Mitchell land: SW. corner of SE. ¼ sec. 29, T. 36 N., R. 5 E.

	Feet.
1. Limestone, cherty	105
2. Shale or "slate"	247
3. Limestone, no chert	120
Total (hole abandoned at this depth)	472

Record of drill hole No. 2, on the Hunt land: NE. ¼ of NE. ¼ sec. 32, T. 36 N., R. 5 E.

	Feet.
1. Shale and limestone, no chert	200
2. Limestone	280
3. Limestone, with galena	135
4. Sandstone.	
Total	615

In the holes sunk on the Derby Lead Company's land and vicinity, Mr. George J. Cole reports that shale or slate, interspersed with layers of limestone, from 144 to 160 feet thick in all, was encountered.

POTOSI LIMESTONE.

The rocks of this formation are found principally west and north of the area here treated of, and they occur within it only over the hills. The upper limits of the formation are, therefore, not reached, and it is probable that no sharp line of separation between it and the underlying St. Joseph limestone exists; hence the full thickness can not be given. At Mine La Motte Mr. Mills has placed the thickness of his "cherty" limestone—which is essentially the same as the Potosi—at 270 feet, and this is probably as great a thickness as it attains anywhere within the limits of the area shown on the accompanying map.[1]

These limestones are essentially the same as those of the St. Joseph formation, the difference between the two formations being in the prevalence of chert and drusy quartz in the Potosi. These are found principally in a residuary form, scattered through the clays and other materials which cover the surface; but they are also found in the rock, though not so abundantly as the profusion over the surface might lead one to expect.

Two principal forms of chert are distinguishable, the one dense, intensely hard, nearly white, with a conchoidal fracture, in appearance not unlike some varieties of porphyry, sometimes found in blocks 6 feet and more in diameter; the other, the drusy quartz known as "mineral blossom." The latter is found in great abundance over the surface in gnarled, irregularly shaped masses, both large and small; it consists of layers of amorphous chalcedonic silica covered with quartz crystals on the free surfaces. In the solid rock it is found lining cavities, in the forms of pipes and sheets; it is intimately mixed with the limestone, and was probably formed by a segregating action at an early stage in

[1] Geological Report on the Mine La Motte Estate, by James E. Mills, New York, 1877.

the history of the latter. There is no direct connection between this rock and the occurrence of ore; their association is simply a coincidence, but it was seized upon by the early settlers as a possible suggestion, which has been handed down.

The way in which these residuary cherts are found over the surface leads to the conclusion that they are not uniformly distributed through the formation, but are segregated in patches of greater or less extent, and that they have a quite variable vertical as well as horizontal distribution. Moreover, these remains are so imperishable that they may cover the surface in great profusion long after all of the limestone in which they were contained has been disintegrated and removed. It is impossible in many instances to determine whether this is the case or not. Hence, in mapping the formation the best that can be done is to outline those areas over which the profusion of chert remains is so great, and the topographic conditions are such, as to warrant the belief that they are in place and not transported.

STRUCTURE.

The structure of the area is so simple, and is so clearly expressed in the geological maps and cross-sections, that little need be said here.

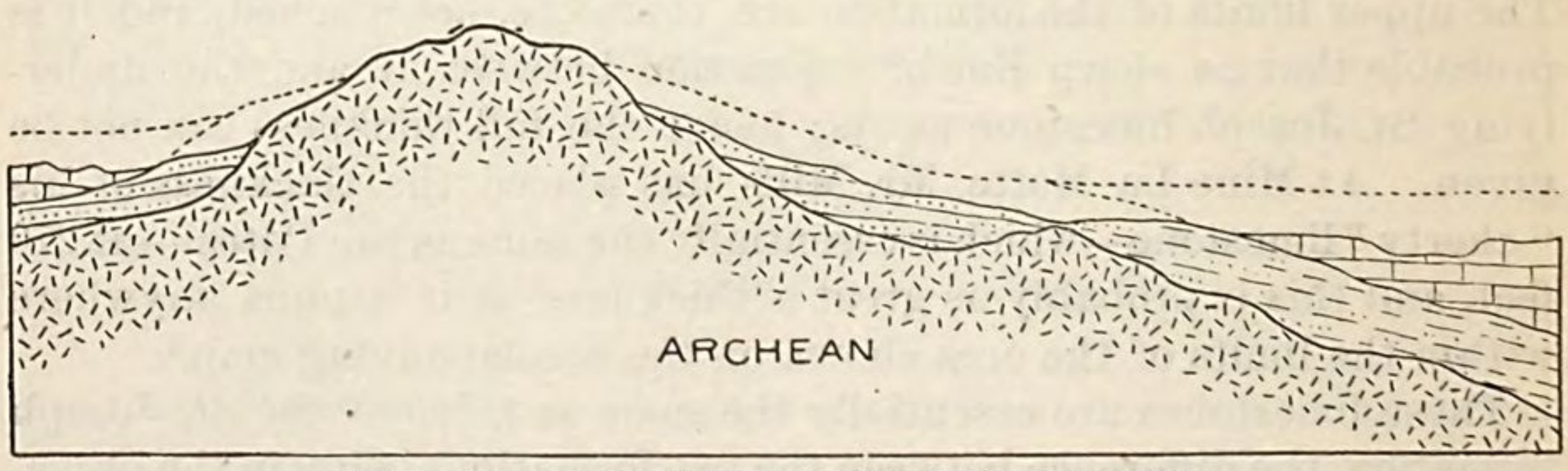


FIG. 1.—Diagram illustrating conditions of sedimentation.

One controlling condition to be borne constantly in mind is that the sedimentary rocks have been laid down upon a very uneven floor, and in large part in quite shallow basins in which numerous islands of Archean crystallines occurred. This is especially the case over the southern portion, about Mine La Motte. Local inclinations of the rocks have thereby been produced which resemble dips caused by flexing, whereas they are in fact merely the results of sedimentation upon a sloping floor. Another outcome of these preexisting conditions is a great variability in the character, and especially in the thickness, of the strata, and some anomalies in distribution arise. Thus the basal La Motte sandstone, clinging to the Archean floor, may extend much farther up a submerged hillslope than does the overlying St. Joseph limestone, and may hence be topographically much above the latter in closely adjoining localities, as is illustrated in fig. 1. Or, again, over a shallow marginal platform covered with the sandstone of shore origin the St. Joseph limestone may never have spread itself, but may have

been confined to the depths of the basin beyond, while the later-formed and higher Potosi limestone may extend over the platform and thus be directly in contact with the sandstone without any erosion period having intervened. This is illustrated in fig. 2. Other combinations will suggest themselves without further elaboration, and the observer must be constantly on guard lest they mislead him.

The general structure of the area is seen to be that of a great basin between the main Archean area to the southwest and the granite outliers of St. Genevieve County to the east. This depression may be in part a product of flexing, but it is to be considered in the main a basin of erosion dating from Algonkian or Cambrian time. The shape of this basin we have been able to define with some degree of accuracy from the results of deep drillings in search of ore. The distribution of these drill holes is shown on the geological map (Pl. I), and in each case the altitude of the surface and of the underlying sandstone is noted. A study of these notes and of the colored cross-sections (Pl. II) accompanying the map will reveal the fact that the trough of the basin follows approximately a line running from the Derby shaft on Flat River south-

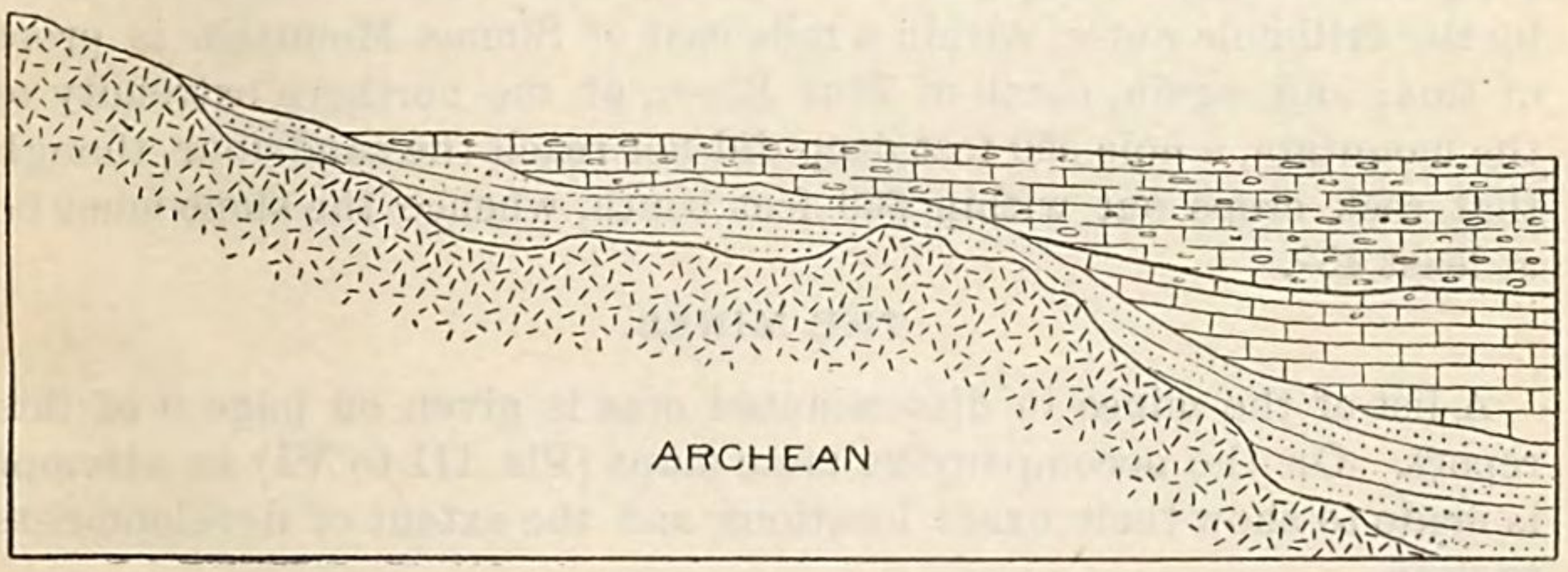


FIG. 2.—Diagram illustrating conditions of sedimentation.

ward to Delassus, and thence toward Knob Lick, where it is interrupted by the granite archipelago near that place, and apparently transferred northward so as traverse the northern part of the Mine La Motte estate. The bottom of this trough, or, more exactly, the surface of the sandstone along its axis, is about 250 feet above tide on Flat River and south of there to the St. François River. The deepest point known is in the northeast corner of the Mine La Motte estate, where the sandstone floor is only 90 feet above tide. Thence it probably deepens southeastward.

The only faults of magnitude which have been recognized traverse the Mine La Motte estate. Two have been located there, running parallel to each other in a northwesterly-southeasterly direction. Of these, the minor one, known as the Main fault, traverses the mines. It consists of a series of short throws, or step faults, aggregating within the limits of the map from 25 to 150 feet, increasing southeastward. It is

described in detail in the report of the Missouri Geological Survey,[1] and the description will not be repeated here. The other is much more extensive; the throw where it crosses Big Rock Creek is about 300 feet, and 2 miles southeast of that point it is nearly 700 feet. Both of these faults are represented in the maps and cross-sections of the La Motte mine. It is probable that other faults will be located in the future, very likely continuations of those described; but even these the writer is inclined to ascribe more to the nature of the original floor and to the conditions of deposition than to movements of rupture. The Main fault is parallel to the axis of a local basin of which the granite walls are probably very steep; the consolidation of the sediments by pressure of overlying deposits would naturally cause a breaking and slipping of the beds along a line parallel to the unyielding walls. The other fault, north of the Main fault, is apparently parallel to and just beyond the edge of a platform of Archean rocks from which there is probably a steep slope of the old surface. This, together with the consolidation of the sediments, may have produced a fracture or series of fractures along this line. That the slopes of the Algonkian land surface were often very steep is evident in many places. The depth of the sandstone, as shown by the drill-hole notes, within a mile east of Simms Mountain is proof of this; and, again, north of Flat River, at the northern extremity of the mountain, a hole 550 feet deep did not reach the sandstone, though that rock crops out within 600 feet south, whence the slope must be at least 45°.

THE MINES.

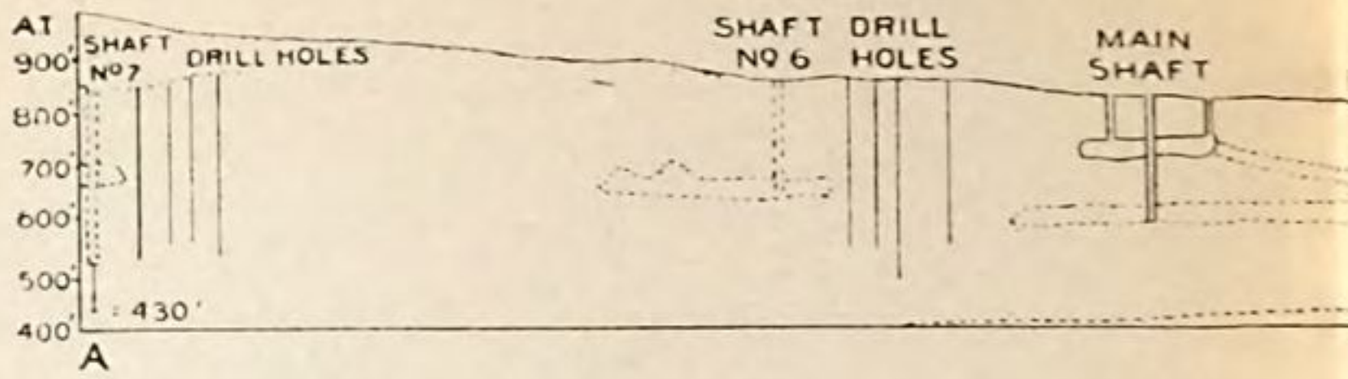
A list of the mines in disseminated ores is given on page 9 of this report. On the accompanying mine maps (Pls. III to VI) an attempt is made to show their exact locations and the extent of developments to date.

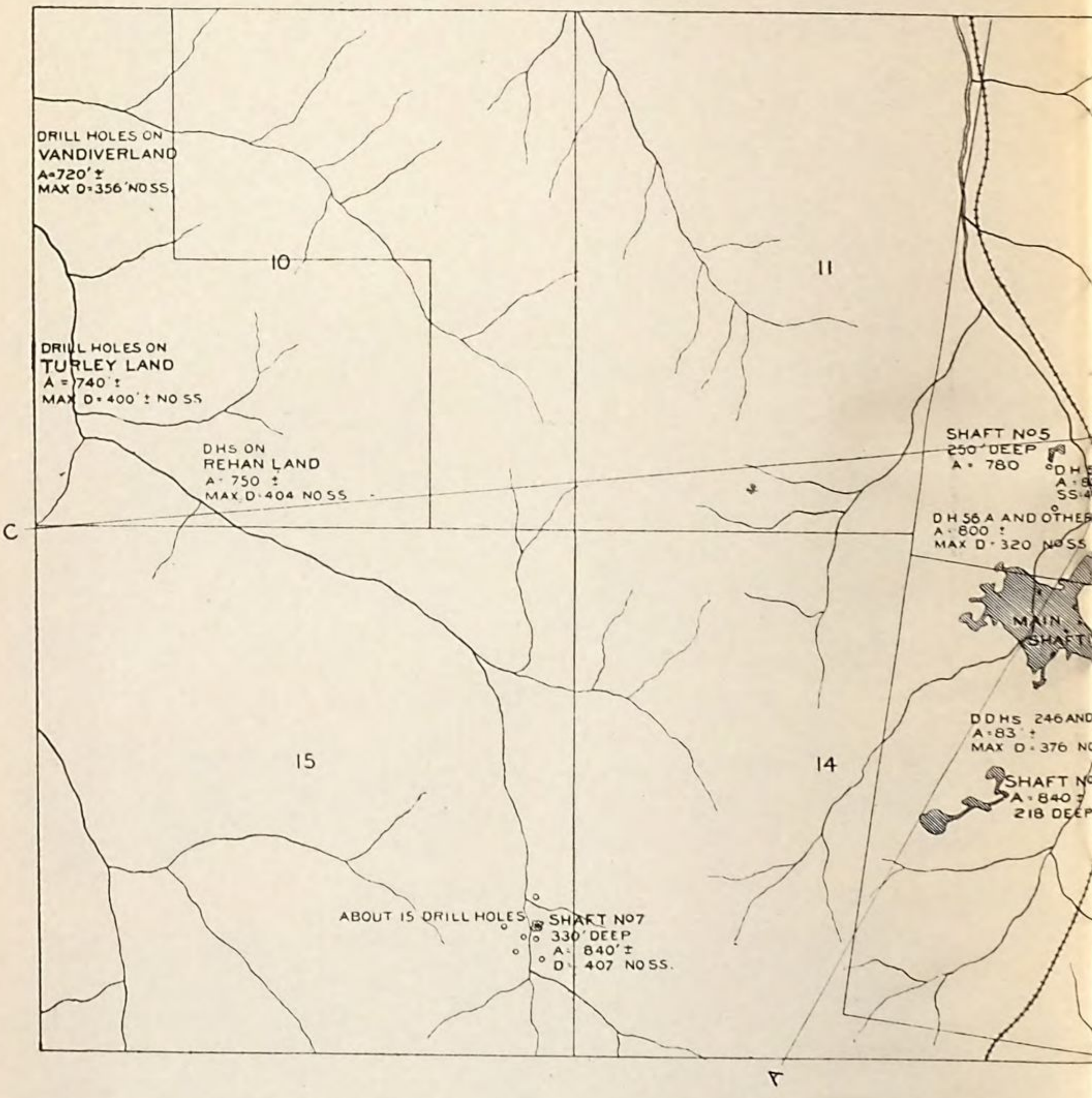
BONNE TERRE MINES.

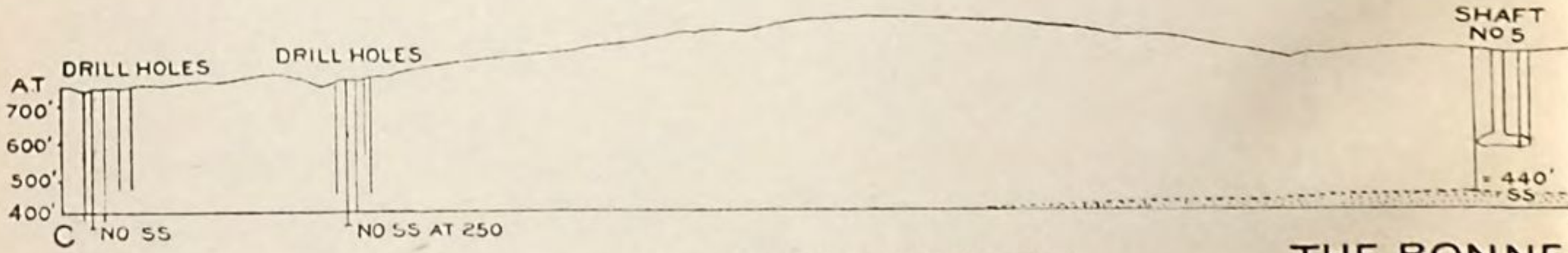
The St. Joseph Lead Company's mines are situated at Bonne Terre. Five separate openings may be distinguished. The first, worked by the main shaft and by a number of other shafts, is by far the most extensive. It is nearly three-fourths of a mile long and over half a mile wide. Five different levels are distinguished at depths of 80, 118, 158, 205, and 230 feet. Ore is found, thus, practically from the surface down to 250 feet; in fact, in the early days of mining the disseminated ore was taken out here in an open cut. Shaft No. 4 is 280 feet deep and the workings are quite small, as is shown on the map. Shaft No. 5 is 250 feet deep and only a small area has been mined out at the bottom. Shaft No. 6 is 218 feet deep. The drift is at the bottom, and the excavation, though larger than that of Nos. 4 or 5, is still quite small as compared with the main mine. Shaft No. 7 is 330 feet deep. It is a new opening. Ore was found at a depth of 170 feet and was excavated for a distance of about

[1] Vol. VIII, 1894, Lead and Zinc Deposits, p. 657.

U. S. GEOLOGICAL SURVEY







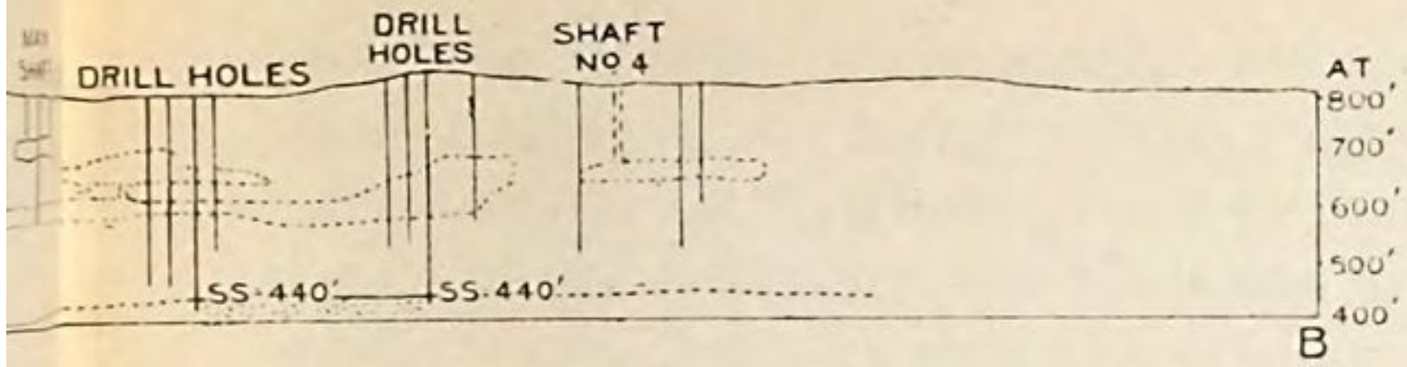
A = ALTITUDE OF SURFACE
SS = ALTITUDE OF SANDSTONE

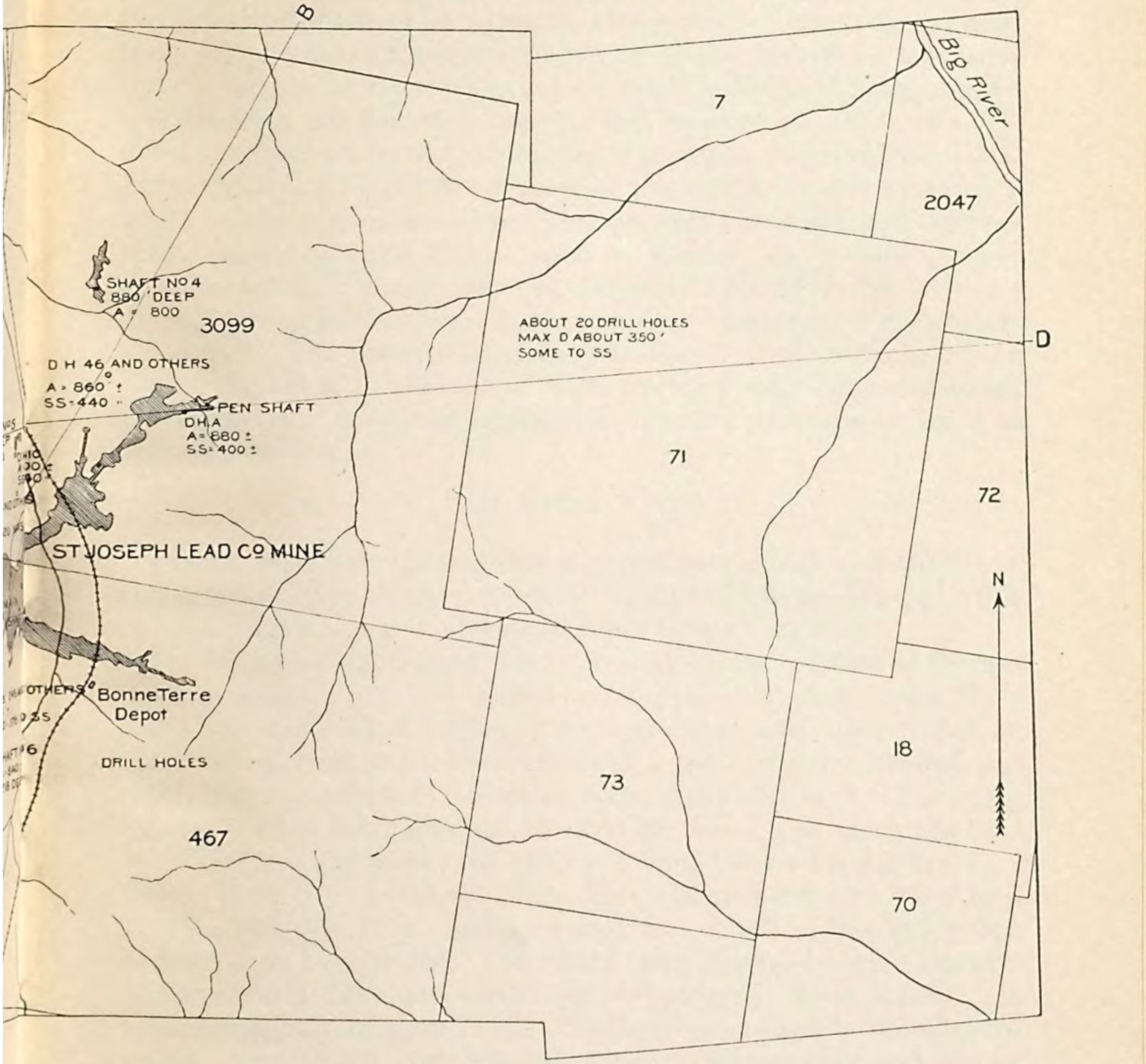
THE BONNE

D = D

SC

0 1/4 1/2





E TERRE MINES

DEPTH

SCALE

3/4 1 1 1/4 1 1/2 MILES

▪ SHAFT

o = DRILL HOLE

50 feet on all sides of the shaft. Between this depth and the bottom, where drifts are now being started, more or less galena was found almost continuously. A drill hole sunk here to a depth of 407 feet did not reach the La Motte sandstone, but shale and chlorite were encountered at that depth, which indicate that the sandstone is not far distant. The sections given on pp. 13–14 illustrate the character of the rocks encountered here. In general, the upper hundred feet or so contain more or less shale, and the magnesian limestone is, in part, thinly bedded and flaggy; under this are some 200 feet of thicker-bedded, massive limestone, in which the ore occurs; below this, again, there is argillaceous shale for about 30 feet, followed by 100 feet or more of magnesian limestone, which is sandy to a greater or less extent and contains also some thin layers of shale; this is followed by the basal sandstone. As is shown on the cross-sections of the mine map (Pl. III), the La Motte sandstone is at a depth of 400 or 440 feet beneath the surface, and appears to dip slightly southward. The production of the St. Joseph Lead Company during 1894 amounted to 15,826 tons of lead; the total output from this camp up to the end of that year aggregated, in round numbers, as much as 215,000 tons of lead.

FLAT RIVER MINES.

The mines of this camp are all very recent openings, and the developments are consequently quite small. They bid fair, however, to attain the dimensions of the Bonne Terre mines before very long.

The Desloge Consolidated Lead Company's mine consists at present of three shafts, which are located on the map. Of these shafts, No. 2 is the only one worked as yet. Two runs of ore have been drifted on here. The bottom of the lower run is at a depth of about 320 feet, and the face of the drift is in places as much as 60 feet high. The upper run is between the depths of 190 and 270 feet. The sandstone is at about 380 feet, and some little galena is found between it and the lower level. Shaft No. 1 is the old Bogy shaft, and connects with No. 2 by a tunnel. Shaft No. 3 has just been sunk to a depth of nearly 300 feet, and will soon be operated. The rock passed through in these shafts is almost entirely limestone, little shale being noted. Much chlorite was found, especially in shaft No. 3. The sandstone floor is nearly horizontal. The mine is equipped with a large concentrating mill having a present capacity of 350 tons per day and an anticipated capacity of about double that amount. Four furnaces are in operation, and all the preparations are for a large output.

The Flat River Lead Company's mine, or the Taylor shaft, is yet in embryo. The shaft is 308 feet deep, and an incline extending thence 200 feet northward reaches 23 feet deeper. The first ore was encountered at a depth of about 160 feet, and from there to the bottom disseminated galena was passed through at frequent intervals, in yellow, white, and gray limestone. No shale is recorded in the section of the

shaft. Sandstone is reached in drill holes at a depth of about 425 feet. It is thus over 70 feet lower than at the Desloge shaft, and it must consequently rise in that direction. On the other hand, as will be seen later, the sandstone is here also about 50 feet lower than at the Crawley shaft to the east. Consequently, the Taylor shaft must be somewhere near the center of a basin. Much water has been encountered here, which has obstructed mining, and undoubtedly its central location in this trough is the reason for this, as the water comes from below.

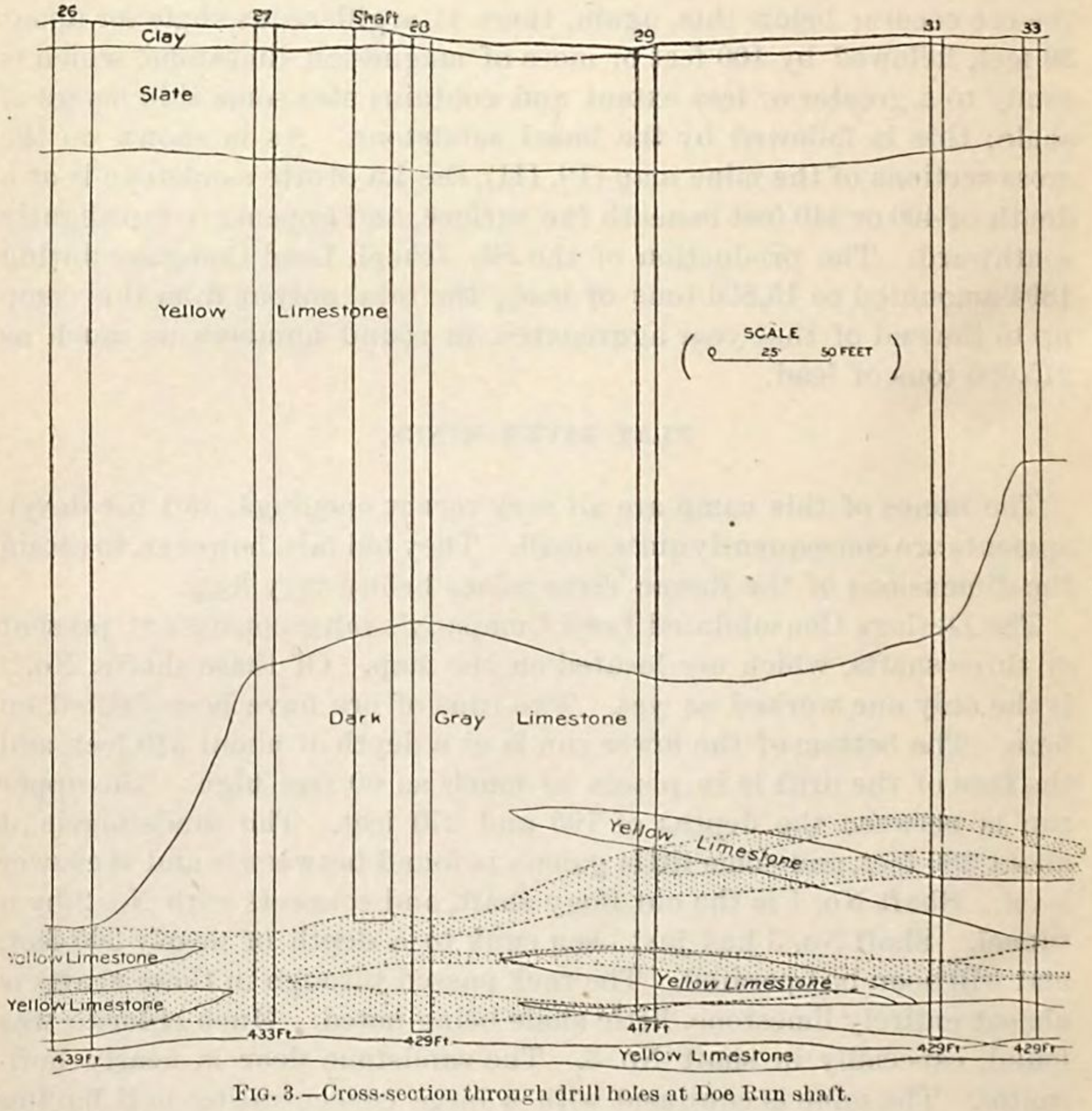
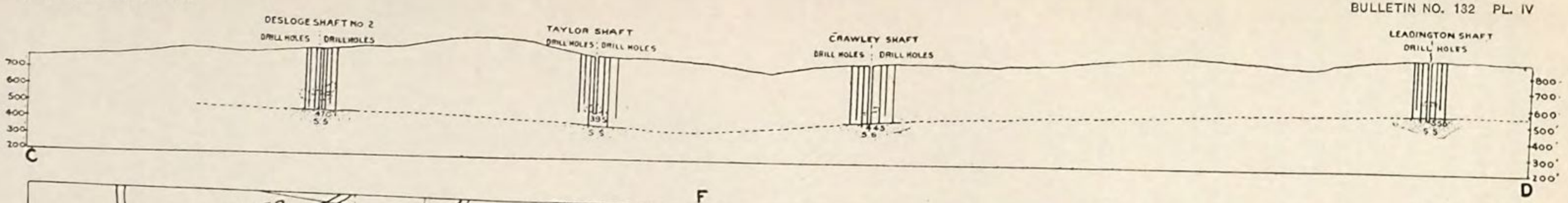
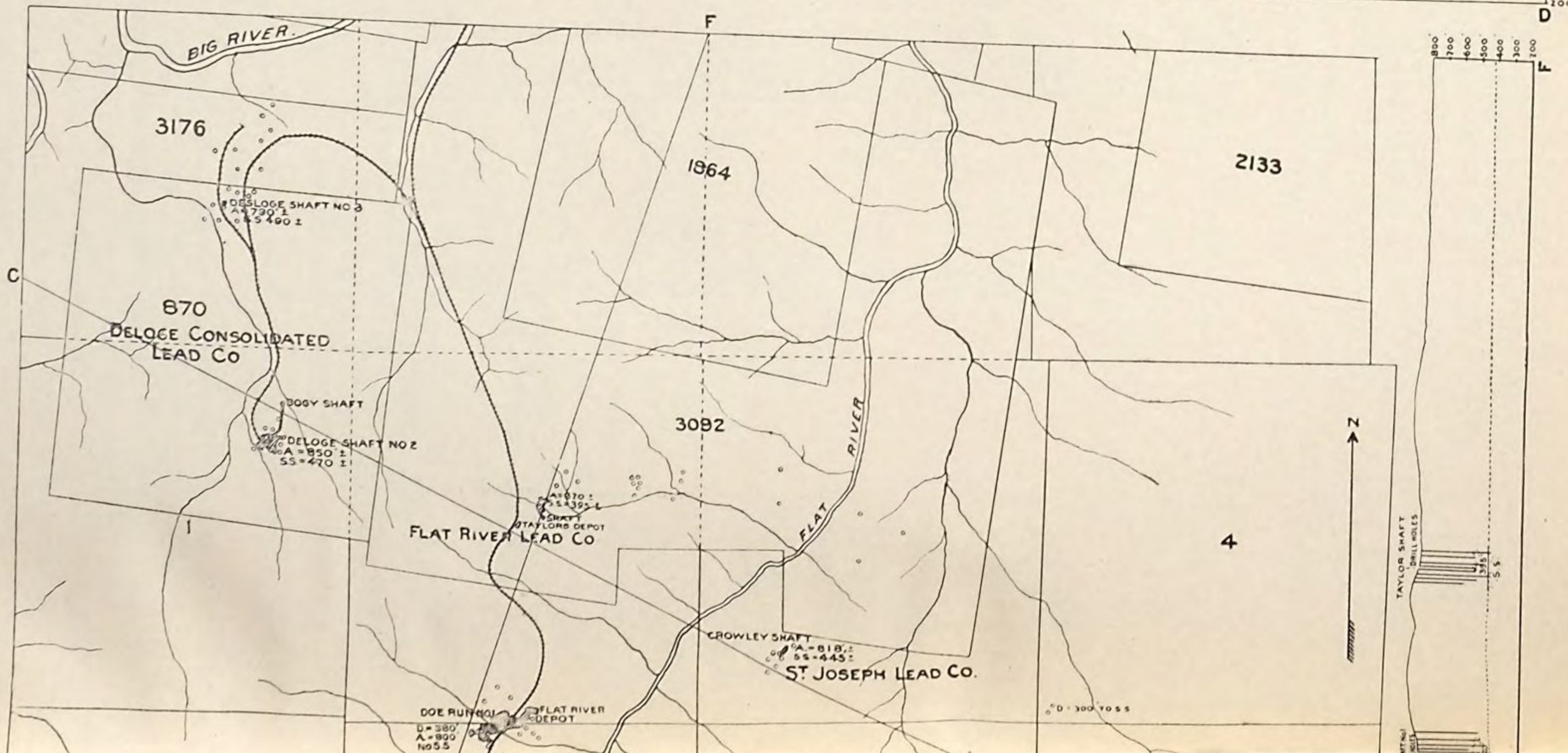


FIG. 3.—Cross-section through drill holes at Doe Run shaft.

The production of this mine in 1894 was 237 tons of lead, and its total production to date is 525 tons of lead.

The Doe Run Lead Company's mines, on Flat River, consist of two openings, numbered 1 and 2. No. 1 is now abandoned. The shaft was 380 feet deep, passing through gray magnesian limestone and frequent beds of shale. Only one run of ore was worked, and this was near the bottom of the shaft. The flooding of the mine with water from a channel which runs near the southern edge of the workings caused the abandonment of this mine. Shaft No. 2 has been opened


DESLOGE SHAFT No 2
DRILL HOLES : DRILL HOLES
TAYLOR SHAFT
DRILL HOLES : DRILL HOLES
CRAWLEY SHAFT
DRILL HOLES : DRILL HOLES
LEADINGTON SHAFT
DRILL HOLES
700
600
500
400
300
200
800
700
600
500
400
300
200
C
D
470
55
392
55
445
56
556
55


BIG RIVER
3176
1964
2133
F
E
C
870
DELOGE CONSOLIDATED
LEAD CO
DESLOGE SHAFT NO 3
A=790 ±
SS 490 ±
DOGGY SHAFT
DELOGE SHAFT NO 2
A=850 ±
SS=470 ±
3092
FLAT RIVER LEAD CO
A=870 ±
SS=395 ±
SHAFT
TAYLORS DEPOT
FLAT RIVER
1
4
CROWLEY SHAFT
A=818 ±
SS=445 ±
ST JOSEPH LEAD CO.
DOE RUN NO 1
D=380'
A=800
NO SS
FLAT RIVER
DEPOT
D=300 TO SS
N
TAYLOR SHAFT
DRILL HOLES
345
55

DOE RUN LEAD CO.

DOE RUN NO 2
A = 780' ±
D = 400 NOSS

CENTRAL SHAFT
A = 810' ±
D = 320' ±

CENTRAL LEAD CO

THEODORA LEAD CO
A = 840' ±
SS = 480' ±

LEADINGTON LEAD CO
LEADINGTON SHAFT
A = 880' ±
SS 550' ±

DONNELLY LEAD CO.
DONNELLY SHAFT
A = 870' ±
SS = 550' ±

DERBY LEAD CO
DERBY SHAFT
A = 900' ±
SS = 260' ±

ELVING

3272

12 11 9 8 13 17 16

A B D E

DOE RUN SHAFT NO 2
DRILL HOLES : DRILL HOLES

DOE RUN SHAFT
DRILL

DERBY SHAFT
DRILL HOLES : DRILL HOLES

FLAT RIVER
DOE RUN SHAFT NO 2.
DRILL HOLES DRILL HOLES
CENTRAL SHAFT
DRILL HOLES : DRILL HOLES
THEODORA D H
DONNELLY SHAFT LEADINGTON SHAFT.
NO BE AT 370'
460
SS
530'
550'
800 700 600 500 400 300 100

A. ALTITUDE OF SURFACE.
SS. ALTITUDE OF SANDSTONE.

THE FLAT RIVER MINES

D. DEPTH
■ SHAFT ○ DRILL HOLE.

Scale.
0 ¼ ½ 1 1¼ 1½ MILES

within the last two years. The depth to the bottom of the sump is nearly 460 feet, and no genuine sandstone was reached, though the green chloritic beds, which are close to that rock, were penetrated. Two runs of ore are distinguished—one at a depth of 430 feet, the other at 403 feet. The lower run, so far as developed, varies in thickness from 1½ to 8 feet. The upper run is not quite so thick at the shaft, but drillings show an increase to the south. These conditions are, however, very variable, as is illustrated in the accompanying cross-section of drill holes here, kindly contributed by Mr. O. M. Bilharz, the assistant superintendent. The ore, as taken out, contains about 170 pounds of galena to a mine car of rock weighing about a ton or less. The lower drift runs in a general northeasterly-southwesterly direction. Parallel to the workings on the south side is a crevice, or channel, from 5 to 40 feet from the drift, with a course about east-northeast. The flow of water from this crevice was very heavy when it was first struck, but by tapping with drill holes and cautious cutting the water was drawn off without difficulty. Where cut at one point the crevice is about a foot wide, and a fault with an upthrow of about 15 feet on the south side is reported; beyond the crevice, however, drill holes show the ore body to be at the normal level, so that the effects of the faulting are not very persistent. Yellow clay and discolored, oxidized rock fragments were found in this crevice, indicating that it connects directly with the surface. The ore from this mine is shipped for treatment directly to the works of the company at Doe Run. The shaft is well equipped for a large production.

The Central Lead Company's mine consists of one shaft 380 feet deep. The principal ore body is at the bottom, near the sandstone floor; it varies in thickness from a few feet to as much as 20 feet. Another run of ore was encountered at a depth of 240 feet, but it is of minor importance, and very little work has been done there. The sandstone is at a depth of about 390 feet, or at an altitude of 420 feet above tide; this is 100 feet above the bottom of the Doe Run shaft No. 2, and consequently the slope of the sandstone must be quite steep between the two; possibly there is some faulting over and above that exhibited along the channel in the Doe Run shaft, but there is no direct evidence of this. This mine is equipped with a good hoisting plant, shops, and a concentrating mill. It is producing now about 100 tons of concentrates per week, and the mill is being enlarged so that it will have double its present capacity. The production during 1894 was 1,719 tons of concentrates, averaging about 65 per cent of lead. The total production of the present company to the end of that year is 1,819 tons of concentrates. Crevices traverse the workings on the south side with nearly due east-and-west courses. They are not open, like the one encountered at the Doe Run No. 2 mine, but are tight, knife-edge-like seams, which are traced by the drip of the water along the roof and by occasional offsets in the rock of a few inches.

The Derby Lead Company's shaft is now being sunk, and is about 120 feet deep. The intention is to sink it to a depth of 490 feet, which will be about 40 feet into the ore body. The sandstone is here at a depth of about 540 feet. Most of the lead ore encountered in the drill holes was through the lower 100 feet.

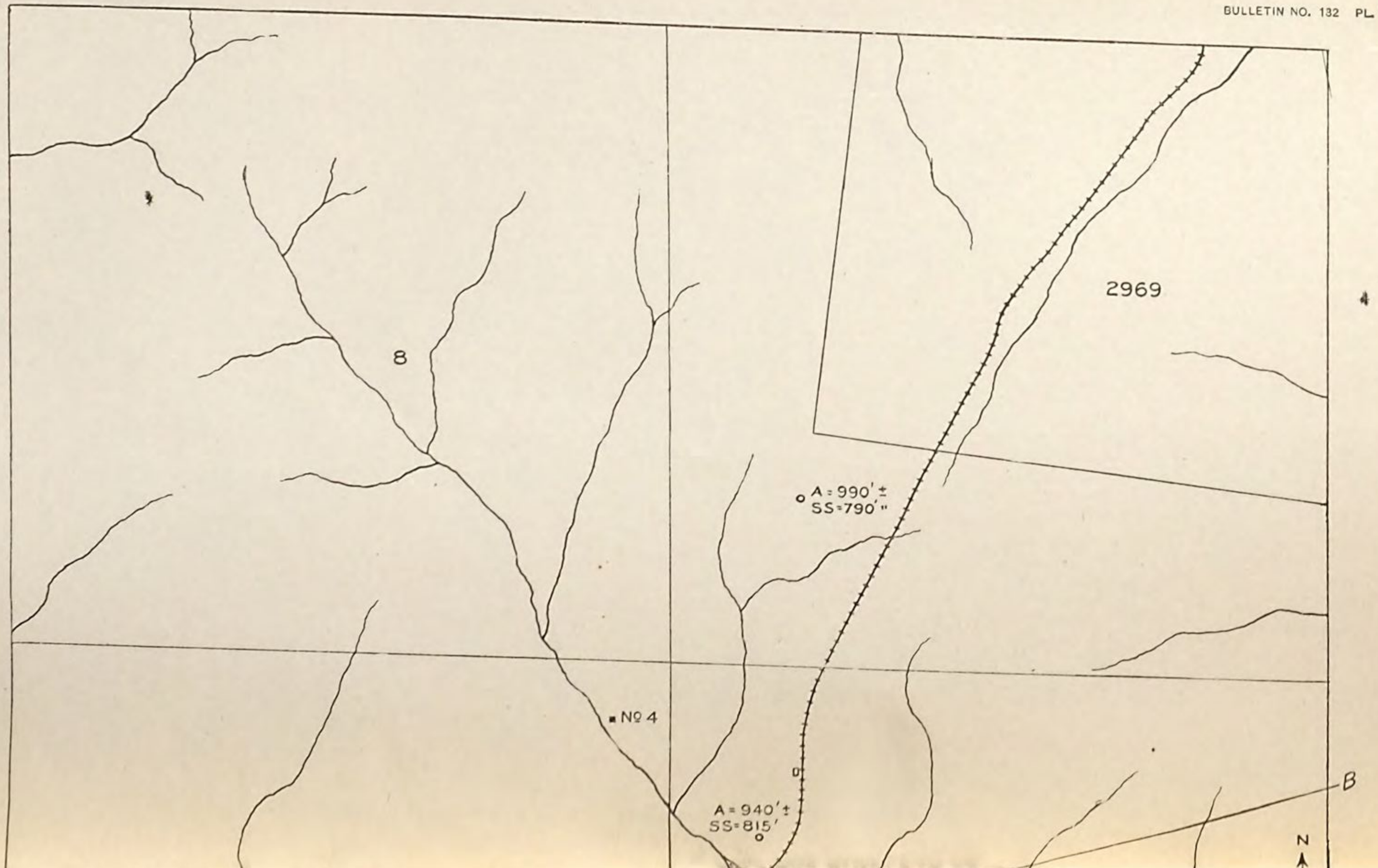
The Crawley shaft of the St. Joseph Lead Company is 365 feet deep, at which depth the sandstone was entered. An upper run of ore was encountered at 283 feet, and a drift about 100 feet long and 40 feet high has been driven in a northeasterly direction. A lower run of ore is at 360 feet, and is about 20 feet thick; the drift at this level is only about 30 feet long. A bed of pyritiferous limestone nearly 10 feet thick was passed through at a depth of about 173 feet. Very little pyrite is associated with the galena, however. A crevice, or "channel," runs along the west side of the upper ore body parallel to the course of the upper drift. The output of the shaft is shipped directly to Bonne Terre for treatment, and is included in the productions of that mine.

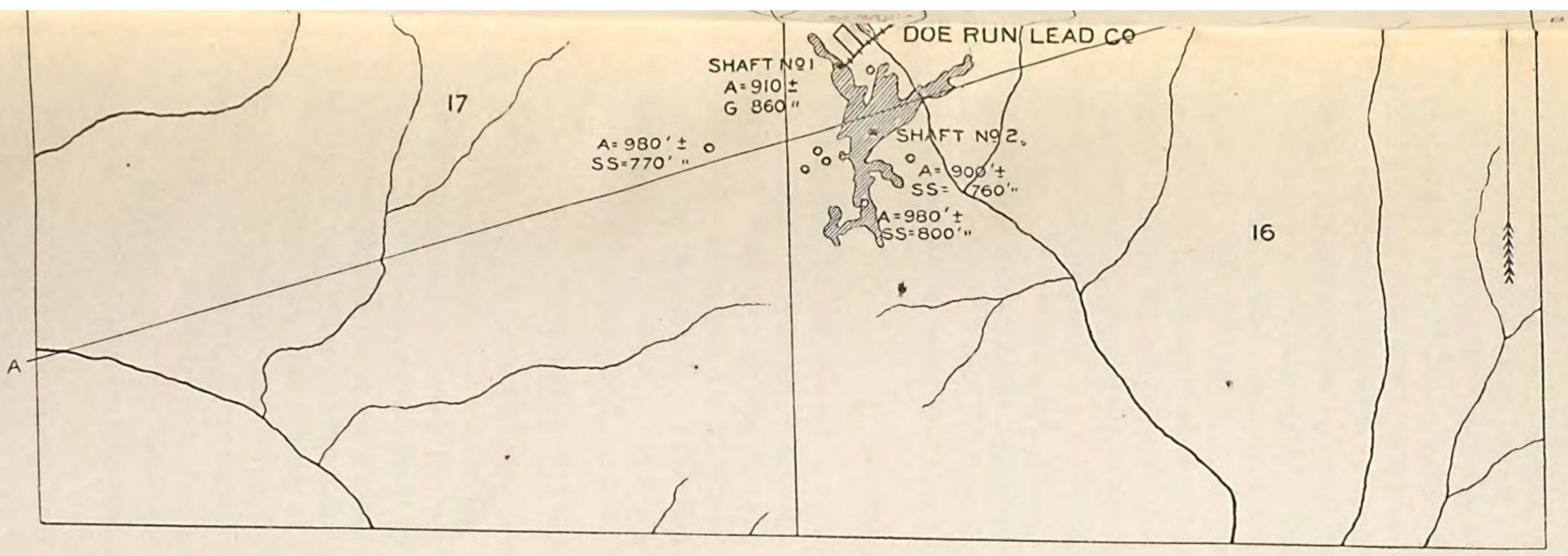
The Donnelly Lead Company's shaft is 310 feet deep, and the sandstone is struck at about 320 feet. The run of ore, which is at the bottom of the shaft, is about 10 feet thick. A drift follows this in a northeasterly direction for about 260 feet; a good deal of the cobalt-nickel sulphide, linnæite, was found in this drift. The ground is traversed by a number of crevices running a little north of east across the drift. At a depth of 125 feet an upper and smaller run of ore was passed through, in which a good deal of pyrite was found. The mine is equipped with a small concentrating mill, and the product has been hauled in wagons to Flat River. Only a small amount has been produced, however—not more than 50 tons of concentrates.

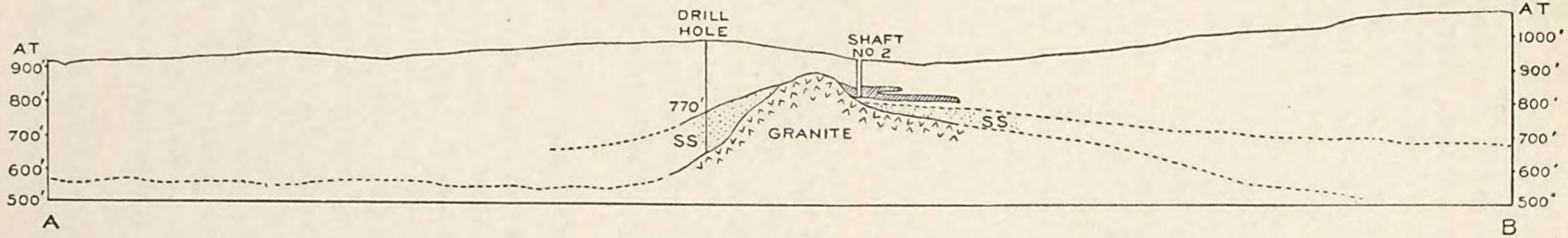
The Leadington Lead Company's shaft is 350 feet deep, and extends 20 feet into the sandstone. About 250 feet of drift has been driven at the bottom. The ore body varies from 8 to 25 feet in thickness. The mine is not now operated. It is equipped with a concentrating mill, from which there were hauled in 1894 about 350 tons of concentrates, and this is the total to date.

DOE RUN MINE.

The Doe Run Lead Company's mine at Doe Run is now almost idle. It was operated by two shafts, 47 and 110 feet deep, respectively. The ore was found principally between the depths of 50 and 90 feet. It lies very near the contact of the St. Joseph limestone with the Archean granite, and surfaces of the latter are exposed in the mine workings. The production of the Doe Run Company in 1894 amounted to 4,203 tons of concentrates, which yield about 65 per cent of lead. Only about one-fourth of this was from the mine at Doe Run, the remaining three-fourths coming from the company's shafts on Flat River. The total production of the company to the end of 1894 amounted to 21,300 tons of lead, of which nearly 5,000 tons came from the Flat River shafts.


2969
8
A = 990' ±
SS = 790'
№ 4
A = 940' ±
SS = 815'
B
N





THE DOE RUN MINE

A = ALTITUDE OF SURFACE SS = ALTITUDE OF SANDSTONE G = ALTITUDE OF GRANITE ▪ = SHAFT o = DRILL HOLE

SCALE

0 1/4 1/2 3/4 1 MILE

MINE LA MOTTE.

These deposits have been worked in many different ways. The earlier diggings consisted largely of open cuts. The principal underground developments of recent years have been at shafts Nos. 1 and 2, which are about 110 feet deep; at shafts Nos. 3 and 4, about 125 feet deep; at shaft No. 5, about 140 feet deep; and quite recently at shaft No. 6. These are located on the mine map (Pl. VI) and have been fully described in the writer's report of the Missouri Geological Survey. Two ore horizons are recognized, belonging to an upper "Black rock" and to a lower "White rock." Their aggregate thickness varies from 70 to 144 feet; they are sometimes separated by about 6 feet of gray limestone. The White rock is close upon the basal sandstone. The deposit occurs in a somewhat shallow basin between outcrops of granite, the axis of which pitches eastward. A fault, or a series of slips accompanied by crevices, traverses or is contiguous to the workings of the shafts, excepting No. 6; it runs in a northeasterly-southwesterly direction. The mine is equipped with a good-sized concentrating mill and with furnaces for the reduction of the ore. The production for 1894 was 2,626 tons of lead. The total yield of the Mine La Motte deposits to the end of that year was approximately 100,000 tons of lead.

AVON MINES.

The Avon mines deposit consists of galena in thin sheets and also disseminated in coarse sandstone, of which latter ore a bed about 2 feet thick was seen by the writer in 1895. The deposit is represented on the map as in the La Motte sandstone, but it belongs to the upper part of that formation, where beds of magnesian limestone alternate with beds of sandstone. The top of the uppermost sandstone stratum is here taken as the dividing line.

GENERAL DISTRIBUTION OF THE ORE.

The ore bodies thus far developed are outlined by the various mine maps, but, beyond their immediate limits, further extensions have been proved in almost all cases by careful drilling. These holes are shown on the larger-scale mine sheets (Pls. III to VI), and toward them the workings are now being extended. In addition, much drilling for purposes of prospecting has been done away from the immediate vicinity of the mines. The distribution of the holes is indicated on the colored map (Pl. I). People are naturally often reticent about divulging the results of such work, for manifest business reasons, and when results are given they must be accepted with a full ounce of precaution. The following brief notes are believed to be substantially correct so far as they go. They relate to different holes approximately located on the map:

West of the town of Bonne Terre, about 2 miles away, a number of drill holes have been put down by the St. Joseph Lead Company. Prom-

ising amounts of ore were found in these within the depths reached. About 1½ miles southwest of these is another drill hole, 320 feet deep, in which pyrite and a trace of galena were encountered at a depth of about 100 feet.

South of Bonne Terre, between shaft No. 7 and Big River, drilling has been done, and ore is reported to have been struck, but the results have not been obtained.

West of French Village, in one of the holes shown, about 3 miles away from that place, a little galena is reported to have been found, while the other holes were all barren. The holes were shallow, however, the deepest only about 265 feet deep, and none reached sandstone.

West of Flat River, and within a mile south of Big River, a number of holes have been put down. These are in the SE. ¼ sec. 5 and the SW. ¼ sec. 4, and in the SE. ¼ sec. 4, the south part of sections 3 and 2, and over adjacent grounds. Galena is reported to have been found in paying quantities in holes put down by the St. Joseph Lead Company, by H. C. Brockmeyer, and others. The maximum depth was about 510 feet and reached chloritic limestone, but not sandstone. Most of the ore was encountered between 375 feet and the bottom, but some was found all the way down. In the NE. ¼ sec. 3 recent drilling is reported to have developed a good body of lead ore at a depth of about 380 feet.

East of Flat River, on the Theodora tract, galena has been found in most of the holes put down. The ore is generally within 20 feet of the sandstone; but in one hole, situated in the midst of the others, some lead was struck at a depth of only 100 feet, and some more at about 200 feet.

North and east of the Leadington and Donnelly mines drill holes have been put down, between them and the corner of St. Genevieve County, some 4 miles distant. Some little ore has been found, but not in many holes, and according to report it disappears eastward as the sandstone outcrop is approached. About a mile southeast of these mines some drilling done a year or so ago failed to discover any considerable amount of ore, but recently a quite rich find was reported from the same tract of land.

North of Simms Mountain and north of Flat River, in sections 21 and 22, several holes have been put down. One of these went to a depth of 558 feet, and neither encountered any lead nor reached sandstone. In another a little ore was struck at 470 feet, and in still another galena was scattered between the depths of 460 and 554 feet.

On the Derby Lead Company's land, in the S. ½ of the SE. ¼ sec. 13, in the NW. ¼ of the NW. ¼ sec. 19, and in the NE. ¼ of the NE. ¼ sec. 24, numerous deep drill holes have been put down. Ore was found in all below the depth of 450 feet. A workable body from 20 to 40 feet in thickness is reported, and galena is scattered through the rock for a depth of 80 feet or more. In the NE. corner of the NW. ¼ sec. 24 a moderate quantity of ore is reported between the depths of 461 and 537 feet. In the SE. corner of the SW. ¼ of the same section galena was found

C.

A=880'± SS.=600'± D.H 90

FAULT

A=950'± SS.=300'± D.H. 755'

D.

B.

JACK DIGGINGS

SEED TICK DIGGINGS

PRAIRIE DIGGINGS

HARD SCRABBLE DIGGINGS.

SHAFT NO.1. A.=870'± SS.=760'±

SHAFT NO.2.

GOLDEN VEIN DIGGINGS.

BLUFF DIGGINGS

SHAFT NO.4 A.=860'± SS.=730'±

CASTOR DIGGINGS

DEEP DIGGINGS

WILD CAT DIGGINGS.

MAIN

A.=830'± SS.=800'±

A.=810'± SS.=770'±

SHAFT NO.5. A.=830'± SS=680'±

A.=810'± SS.=680'±

FAULT

A=810'± SS.=795'±

A.=820'± SS.=650'±

SHAFT NO.6.

A.=830'± SS.=810'±

A.=820'± SS.=680'±

A.=840'± SS.=650'±

A.=840'± SS.=770'±

SS.=90' D.H. 723

A=880'± G.=400' D.H. 694

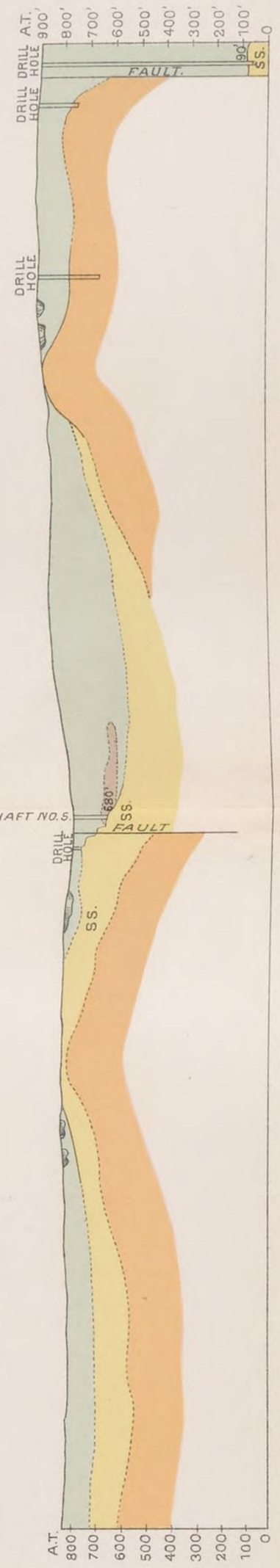
G.=800' D.H. 696

D.H. 517' A.=900'± G.=785'±

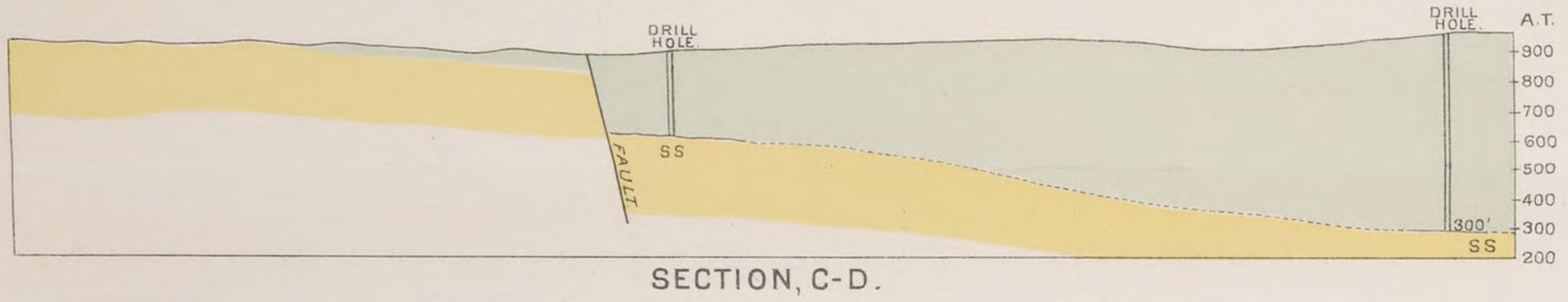
RATTLE SNAKE DIGGINGS.

N

D.W.CRONIN DEL.



SECTION, A-B.



SECTION, C-D.

GRANITE. SANDSTONE. OLD SURFACE DIGGINGS. UNDERGROUND MINES. LIMESTONE.

A. ALTITUDE OF SURFACE. S.S. ALTITUDE OF SANDSTONE. D. DEPTH. ■ SHAFT. ○ DRILL HOLE.

THE MINE LA MOTTE MINES.

0 1/4 1/2 3/4 1 MILE

SCALE.

Lith. A. Hoen & Co. Baltimore.

SEED TICK DIGGINGS

PRAIRIE DIGGINGS

SHAFT NO.1 A-870'± SS-760'±

SHAFT NO.2.

GOLDEN VEIN DIGGINGS

BLUFF DIGGINGS

SHAFT NO.4 A-860'± SS-730'±

CASTOR DIGGINGS

DEEP DIGGINGS

WILD CAT DIGGINGS

MAIN FAULT

A-830'± SS-800'±

SHAFT NO.5. A-830'± SS-680'±

A-810'± SS-770'±

A-810'± SS-680'±

A-810'± SS-795'±

A-820'± SS-650'±

SHAFT NO.6.

A-830'± SS-810'±

A-820'± SS-680'±

A-840'± SS-650'±

A-840'± SS-770'±

JACK DIGGINGS

D.H. 517' A-900'± G-785'±

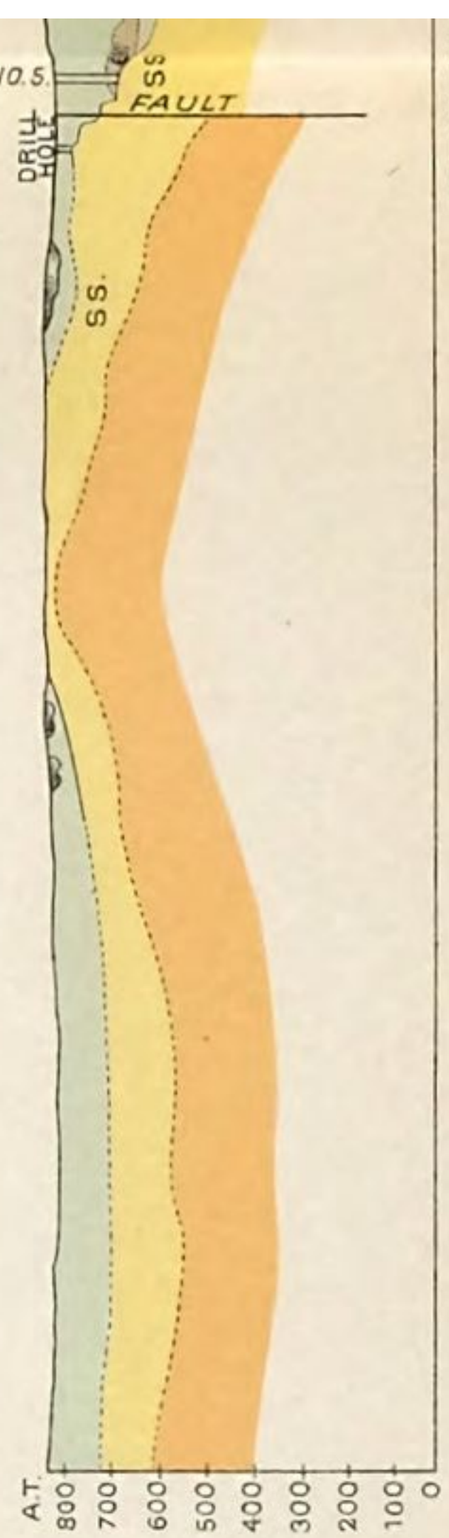
RATTLE SNAKE DIGGINGS

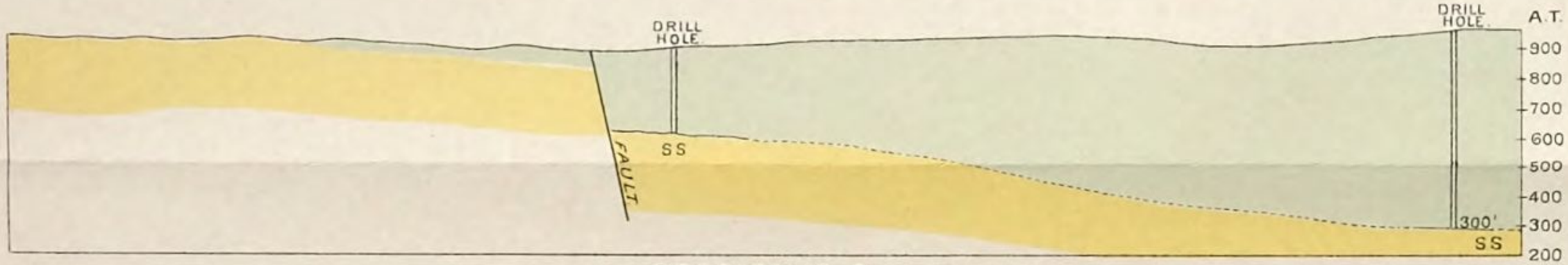
HARD SCRABBLE DIGGINGS

N

D.W.CRONIN DEL.

SECTION, C-D.





GRANITE. SANDSTONE. OLD SURFACE DIGGINGS. UNDERGROUND MINES. LIMESTONE.

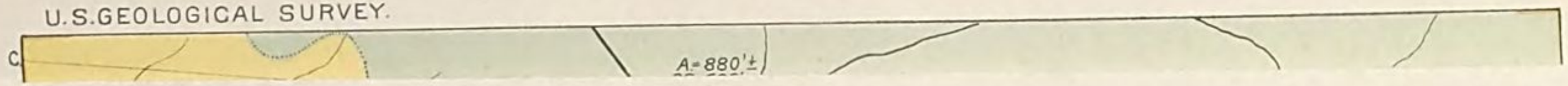
A. ALTITUDE OF SURFACE. S.S. ALTITUDE OF SANDSTONE. D. DEPTH. ■ SHAFT. ○ DRILL HOLE.

THE MINE LA MOTTE MINES.

0 1/4 1/2 3/4 1 MILE

SCALE.

Lith. A. Hoen & Co. Baltimore.


C
A=880'±

scattered through the rock between the depths of 445 and 490 feet. Nearly a mile east of the last, on the creek in the SW. corner of section 19, a good showing of ore is reported between the depths of 539 and 548 feet, and the loss of the bit prevented further drilling, though the hole was still in ore.

North of the railway junction west of Delassus a hole was put down in section 29, near the middle of the south line. No ore was found down to the depth of 472 feet, where the hole was abandoned, but Mr. George Cole, who sunk the hole, believes that lead would have been found at 625 feet. In the NE. $\frac{1}{4}$ sec. 32, just south, ore was passed through between depths of 480 and 615 feet, and in the NW. corner of section 4 and the NE. corner of section 5, a mile south of the last, similar results were obtained.

About Farmington, and in the holes immediately northeast and northwest of that place, no lead ore has been found.

About Delassus a number of drill holes were put down five or more years ago—a dozen or more within a mile or so south of the town; they were quite shallow, however, none being over 200 feet deep, and thus stopped well above the sandstone. A little galena was found between the depths of 75 and 100 feet, but nothing amounting to an ore body.

East of Doe Run between 4 and 5 miles several holes have been sunk, as indicated on the map. Of these, one sunk in the SE. corner of section 24 showed lead ore between depths of 460 and 472 feet, where drilling was stopped because of the breaking of the rod.

North of Knob Lick about 4 miles a drill hole in the NE. $\frac{1}{4}$ sec. 21 revealed no ore.

North of Mine La Motte, in the northern part of the estate, drill holes have, so far, not encountered any ore, at least not in paying quantities.

About Fredericktown a good deal of drilling has been done within the past four or five years, and ore has been found at several places, though none has so far been developed. In a hole about 3 miles southeast of the town a few specks of lead were encountered at a depth of 115 feet. On the eastern edge of the town lead was found in a number of holes, in the lower 30 feet above the sandstone. North of the town about twelve holes were put down, close to the county road, between Village Creek and Mine La Motte; they varied in depth from 35 to 71 feet to the sandstone; no lead was found in any. About a mile southeast of these, on the south side of Village Creek, more holes were sunk, reaching a depth of 180 feet; some little galena was found in these. About 4 miles northwest of the town, near the southwest corner of the Mine La Motte estate, is a bunch of drill holes of which the reports are quite promising; they range in depth up to 120 feet. The records of these holes show that the ore occurs in the lower part, perhaps 10 feet from the sandstone, and consists of a bed of limestone 10 to 15 feet thick, with the galena disseminated in it in coarse grains; some cores are quite rich.

About 5 miles southeast of Fredericktown, on the St. François River, in section 15, west of Slater Creek and about a fourth of a mile east of the river, drill holes reached depths of 180 feet; no lead ore was found in any; the deeper holes reached sandstone, while those farther north went through limestone to granite without encountering any sandstone.

THE ORE BODIES.

The typical ore is the disseminated, consisting of grains of galena intimately mixed with grains of dolomite or calcite, the galena having been introduced by the process of metasomatic interchange. Sheet galena is sometimes found in vertical crevices at higher levels, associated with disseminated ore, but it disappears or is rare at depths. The galena of the disseminated ores is sometimes distributed uniformly throughout the face of rock exposed; elsewhere the mineral is concentrated about certain centers; and, again, the grains of galena are frequently strung out along the stratification planes, sometimes so close together as to form sheets, which vary in thickness from one-tenth of an inch to several inches.

The associated minerals are few and not conspicuous. Calcite is probably the most abundant; it is found in large crystals embedded in clay, in small crystals lining cavities, and in masses embedded in the limestone. Other minerals are iron pyrite, marcasite, chalcopyrite, pyrrhotite, and the rare nickel-cobalt sulphide linnæite. These generally occur in small quantities, but occasional bunches are found, as the experience at Mine La Motte, Bonne Terre, and the Donnelly mine shows. Chlorite, an abundant mineral in the limestone, is also often mixed with the galena.

The shapes of the ore bodies are very irregular and variable; at one point the galena may occupy a bed of limestone only a foot or two in thickness, while within a short distance the impregnation may expand to 10 or 20 feet, and faces of magnificent ore nearly 100 feet thick have been opened. As a rule, no well-defined planes limit these ore bodies in any direction, but the galena contents usually fade or "lean out" into the surrounding barren rock. In some instances, however, stratification planes or crevices mark the limits of the ore.

The horizon of the ore deposits is quite variable, but on the whole they are perhaps more prevalent in the lower part of the St. Joseph limestone, just above or a short distance away from the La Motte sandstone. The ore bodies at Bonne Terre are a notable exception to this, the lowest being 200 feet above the sandstone, and they extend thence to the surface. The nearness of the ore bodies to the sandstone is more pronounced in the Flat River mines; but upper runs of ore are found also, as is illustrated in nearly all of the mines there. At Doe Run the deposit is near the bottom, and at Mine La Motte it also clings to the sandstone, but the basins are shallow in both places. About Fredericktown the ore is also found near the sandstone.

The presence of crevices, commonly called "channels," traversing all of these mines, is a significant fact. In the deep workings they are not, as a rule, open fissures, but are quite tight, and are often traceable only by the drip of the water, with sometimes lenticular expansions. They often connect with the surface, where they are generally open, filled with clay, and contain galena in sheets. Such crevices at Bonne Terre are described in great detail in the report of the Missouri Survey. Many are encountered in the main workings there. The prevailing courses are between east-west and northeast-southwest. Many are nonpersistent, while some are continuous so far as the workings extend. No master crevice or series of crevices is definable; no faulting or displacement was observed. At the Desloge mine joint crevices were seen running from east to west, and the Bogy shaft followed a crevice from top to bottom. In all of the mines of the Flat River camp such crevices traverse or are contiguous to the ore bodies, as already referred to, and all have courses nearly east and west. They are abundant at Doe Run and at Mine La Motte. They undoubtedly favor the accumulation of ore in furnishing passages for the flow of the solutions, but they can not be regarded as of the nature of profound fissures through which solutions have risen from depths. For the same reasons faults are conducive to the formation of ore, but there is only one instance of close association, i. e., at Mine La Motte.

The texture and composition of the rock has doubtless some bearing upon the ore contents. Thus, the deposits are most prevalent in the coarse, open-textured rock, and they also characterize the darker-colored varieties, which doubtless contain some organic matter. Shaly, dense beds have their influence in directing the flow of the waters which traverse them, and hence they indirectly affect the distribution of ore bodies.

The fact that the deposits of Mine La Motte and on Flat River are along or near the axes of basins suggests that there may be something in this structure favoring the accumulation of ore, and the results of drilling south of Flat River also indicate that ore occupies the center of the trough. It seems natural that this should be the case, as the waters or solutions which traverse the rocks from the surface would gravitate toward the center of a basin, and, other conditions being favorable, it would thus be also a center of accumulation. The force of this suggestion is weakened, however, by the location of the Bonne Terre, Donnelly and Leadington, and Doe Run deposits, which are well up on the sides. The absence of ore over the margin of the formation, in the lower beds which crop out just west of the St. Genevieve County sandstone area, is worthy of note.

A glance at the map shows that all of the deposits so far developed are beyond the areas of the Potosi limestone, and drill men are of the opinion that the ore does not occur in disseminated form beneath that cherty rock. This may be the case, but the fact is hardly demonstrated

yet, as inherent difficulties in drilling have prevented holes from being sunk through these rocks. If, however, it prove true that these great ore bodies as a whole are restricted to the country whence these upper rocks have been removed, or, in other words, where denudation and subaerial decay have been greatest, then this is a significant fact. It is in entire harmony with the writer's hypothesis of the origin of the ores. This hypothesis has been so fully presented in the Missouri Survey report that it will be only very briefly outlined here. It derives the deposits from the metals diffused through the country rocks, by means of the surface decomposition of the latter. Minute quantities of the metals being present in not only the limestones but the Archean rocks also, as has been demonstrated by analysis, the metals would naturally pass into solution on the decay of these rocks and be transferred in percolating waters through crevices and other openings to the underlying strata, where they would gather by segregation into deposits of various forms and kinds. In the case of the disseminated ores, the waters flowing from the underlying sandstone doubtless carry metals in solution in minute quantities, largely derived directly from the remains of decaying Archean rocks. These, on entering the limestones, find conditions (which were not afforded in the sandstone) suitable for the replacement of the country rock by galena and for the formation of ore bodies. The metal-containing waters can have found access in other ways also.

In conclusion, the maps and sections accompanying this report show very clearly the limits of the different formations, including the ore-bearing St. Joseph limestone, beyond which it is not advisable to search for disseminated ores. They also define the basins or troughs; and, though it can not be maintained that the ore deposits are confined to these, the writer recommends that these basins be given special attention in the search for ore. Moreover, it is a fact that the developed ore bodies are generally, though not invariably, under areas over which shallow surface deposits have been worked in the past; therefore, other things being equal, such localities should be given the preference. Ground which is known to be traversed by crevices or faults is also to be regarded favorably. It is of great importance to the future of this district that some systematic effort be made to collect and preserve more carefully the results of the drilling which has been done and is being constantly extended by individuals and companies. Only the most general results have been introduced here; could they be more thoroughly studied and compared, mapped and leveled, much of value could be determined which is here only suggested.

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WASHINGTON
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[Bulletin No. 133.]

The statute approved March 3, 1879, establishing the United States Geological Survey, contains the following provisions:

"The publications of the Geological Survey shall consist of the annual report of operations, geological and economic maps illustrating the resources and classification of the lands, and reports upon general and economic geology and paleontology. The annual report of operations of the Geological Survey shall accompany the annual report of the Secretary of the Interior. All special memoirs and reports of said Survey shall be issued in uniform quarto series if deemed necessary by the Director, but otherwise in ordinary octavos. Three thousand copies of each shall be published for scientific exchanges and for sale at the price of publication; and all literary and cartographic materials received in exchange shall be the property of the United States and form a part of the library of the organization; and the money resulting from the sale of such publications shall be covered into the Treasury of the United States."

Except in those cases in which an extra number of any special memoir or report has been supplied to the Survey by resolution of Congress or has been ordered by the Secretary of the Interior, this office has no copies for gratuitous distribution.

On March 2, 1895, the following provision was included in an act of Congress:

"*Provided*, That hereafter the report of the mineral resources of the United States shall be issued as a part of the report of the Director of the Geological Survey."

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CHARLES D. WALCOTT, DIRECTOR

CONTRIBUTIONS

TO THE

CRETACEOUS PALEONTOLOGY OF THE PACIFIC COAST

THE FAUNA OF THE KNOXVILLE BEDS

BY

TIMOTHY WILLIAM STANTON



WASHINGTON

GOVERNMENT PRINTING OFFICE

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LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
Washington, May 30, 1895.

SIR: I have the honor to transmit herewith a paper entitled "Contributions to the Cretaceous Paleontology of the Pacific Coast: The Fauna of the Knoxville Beds." The introductory portion consists of a geological description of the Lower Cretaceous Aucella-bearing series of the Pacific States, with a discussion of its age and of its relations with various other formations characterized by a similar fauna.

The body of the paper is devoted to the description and illustration of the invertebrate fauna of the Knoxville, in which 77 distinct species and varieties are recognized and 50 species are described as new.

Very respectfully,

T. W. STANTON,
Assistant Paleontologist.

Hon. C. D. WALCOTT,
Director United States Geological Survey.

CONTRIBUTIONS TO THE CRETACEOUS PALEONTOLOGY OF THE PACIFIC COAST: THE FAUNA OF THE KNOXVILLE BEDS.

By Timothy W. Stanton.

INTRODUCTION.

DEFINITION OF THE KNOXVILLE BEDS.

Previous to the publication in 1869 of Vol. II, Palæontology of California, the deposits on the Pacific Coast now recognized as Cretaceous were not divided into groups or formations. In that volume Professors Whitney and Gabb gave the name Shasta group to the complex series of Lower Cretaceous beds which they recognized to be of different ages, probably from the Neocomian to the Gault, inclusive. They also proposed the names Chico group, Martinez group, and Tejon group for the beds overlying the Shasta in the order named. Of these the Tejon is now generally believed to be of Eocene age, and the Cretaceous portion of the ill-defined and heterogeneous Martinez group is inseparable from the Chico.

In 1885 Dr. C. A. White[1] and Dr. G. F. Becker[1] recognized two divisions of the Shasta formation, which they called the Knoxville beds and the Horsetown beds. The former, which is especially characterized by the abundant occurrence of Aucella, was named from the village of Knoxville, in the quicksilver mining district of Napa County, Cal., where it is well developed, while the typical localities of the Horsetown beds, characterized by a different fauna, rich in ammonites, were given as the north fork of Cottonwood Creek and Horsetown, in Shasta County.

Although at that time the stratigraphic relations of these two divisions were not known, and they had not even been seen in adjacent areas, subsequent more detailed studies have confirmed the opinions then expressed, both as to the position of the Knoxville beneath the Horsetown and as to the limits between the two. It is true that they have been found to be much more closely connected, both faunally and stratigraphically, than was then supposed, but wherever they have been seen in contact the upper limit of the range of Aucella has proved to be the most natural and convenient line of separation between the

[1] Bulls. U. S. Geol. Surv. Nos. 15 and 19. The divisions were again defined by Dr. Becker, in Mon. U. S. Geol. Surv. Vol. XIII.

two divisions,[1] and the base of the section on the north fork of Cottonwood Creek practically coincides with the base of the Horsetown beds.

The Knoxville may be briefly defined, therefore, as the Aucella-bearing Cretaceous beds on the Pacific Coast of the United States.

GEOGRAPHIC DISTRIBUTION.

Although it is a well-known fact that beds strictly equivalent with the Knoxville occur in British Columbia, and probably in Alaska, Mexico, and more distant regions, it is thought best to limit the present description and discussion of the fauna to species collected within the United States and at localities where the stratigraphic relations are fairly well established. As thus restricted, the Knoxville beds are confined to the coast ranges of California, Oregon, and Washington, where they have been recognized by the presence of Aucella at many localities, from Santa Margarita, San Luis Obispo County, Cal. (a little north of latitude 35°), on the south, to the neighborhood of Seattle, Wash., on the north. Some of the more important localities will be described below.

STRATIGRAPHIC RELATIONS.

The upper limit of the Knoxville beds has already been mentioned. Where the series is complete, as in Tehama County, Cal., the Knoxville is conformably overlain by the Horsetown beds, with a varied and abundant fauna. The lower limit is more difficult to define, because the base is usually either concealed by the intrusion of eruptive rocks or rests on metamorphic rocks of undetermined age. Massive dikes of serpentine (occasionally unaltered peridotite) are very frequently associated with the Lower Knoxville beds throughout the entire area of their occurrence. On the Cold fork of Cottonwood Creek, Tehama County, the underlying rocks include crystalline limestone of probable Carboniferous age.[2] Opinions have differed as to the age of the metamorphic rocks associated with the Lower Knoxville in the areas farther south, some authors, as Whitney, and more recently Becker, holding that they are only altered portions of the Cretaceous beds, while others have thought that they are of pre-Cretaceous age. The latter view has been maintained especially by Mr. H. W. Fairbanks in a number of papers published in 1892 to 1894. One of the latest[3] of these summarizes the arguments for the pre-Cretaceous age of these rocks. The evidence of an unconformity between them and the Knoxville, striking differences in the lithological character of the sediments, and the absence of the Knoxville fauna are the main points advanced to prove

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[1] Practically the same divisions were recognized by Mr. J. F. Whiteaves, in an article "On the Lower Cretaceous Rocks of British Columbia," published in Trans. Royal Soc. of Canada, Vol. I, sec. 4, pp. 81–86, 1882. He did not give a name to the lower division, however, and in his later publications he has denied the validity of the divisions then made, so far as they apply to the Cretaceous of British America.

[2] Diller and Stanton, The Shasta-Chico Series, Bull. Geol. Soc. Am., Vol. V, p. 442.

[3] Review of our knowledge of the Geology of the California Coast Ranges, Bull. Geol. Soc. Am., Vol. VI, pp. 71–102, 1894.

the thesis. These supposed pre-Cretaceous beds have yielded very few definite fossils. At Slates Springs, Monterey County, Mr. Fairbanks obtained a large species of Inoceramus[1] and a few other forms, none of which is referable to Knoxville species, though the Inoceramus is related to *I. quatsinoensis* Whiteaves from the Aucella-bearing Cretaceous of Vancouver Island. *Inoceramus ellioti* Gabb, from the "San Francisco sandstone" on Alcatraz Island, is also referred to this pre-Cretaceous series by Fairbanks, and a few other indeterminate fossils have been obtained from the same beds in the neighborhood of San Francisco. Cherts interbedded with the San Francisco sandstone contain abundant, but badly preserved, radiolarian remains.[2] The paleontological evidence, though meager, indicates that these beds, as well as those at Slates Springs, are not older than Jurassic, but it is not sufficient to fix their age more definitely. While it seems probable that they underlie the Knoxville beds and are unconformable with them, no section has yet been described in which their stratigraphic relations may be clearly seen.

We may say, then, that the Knoxville beds rest on strata of different ages, from the Carboniferous to probable Upper Jurassic, and that they are unconformable on the underlying strata at some places, and probably everywhere.

LITHOLOGIC CHARACTER.

Dark clay shales greatly predominate over all other kinds of rocks in the Knoxville beds, but there is also considerable sandstone, usually in thin beds. In some places the lower part of the formation consists of alternations of shale and sandstone, or calcareous material, in bands only a few inches thick. There are also occasional thicker beds of sandstone, and sometimes massive conglomerates. The larger bodies of shale frequently contain many calcareous concretions, and such concretions are sometimes found even in the coarse conglomerates. More rarely there are larger bodies of limestone, several feet in thickness, but they do not form continuous beds of any great extent. For example, the limestone 3 miles northwest of Paskenta, which has yielded a number of the fossils described in this paper, is only about 100 feet long. The one near Wilbur Springs, Colusa County, may be traced for about one-fourth mile. The conglomerates also appear to be local deposits of no great length, though sometimes of very considerable thickness.

LOCAL DEVELOPMENT.

TEHAMA COUNTY, CAL.

The area on the west side of the Sacramento Valley, extending southward from the north fork of Cottonwood Creek, through Shasta and Tehama counties, shows a better development of the Lower

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[1] Op. cit., p. 93. See also 12th Rept. Cal. State Mining Bureau, p. 519, 1894.

[2] F. L. Ransome, Geology of Angel Island, with a note on the Radiolaria by Dr. G. J. Hinde, Bull. Geol. Dept. Univ. of Cal., Vol. I, pp. 193–240.

Cretaceous, both faunally and stratigraphically, than any other region yet studied in California. Its principal features have been described by Mr. J. S. Diller[1] and the present writer[2] in several papers, from which the following notes are condensed. The object is not to give a full geological description of the areas described, but to give enough to show the associations and stratigraphic relations of the fossils described. In the lists of species from the Knoxville beds the nomenclature is revised in accordance with that adopted in the body of this paper, and whenever there are changes or omissions from lists from the same localities, published in earlier papers, the present lists are to be regarded as more nearly correct.

The most northerly point in Sacramento Valley at which the Knoxville fauna has been found is at Stephenson's, on the Cold fork of Cottonwood Creek, Tehama County. It is certain, however, that the Knoxville beds continue some miles farther north, for their thickness here, as estimated by Mr. Diller, is about 10,000 feet, though they do not extend as far as Ono, some 25 miles north, where the Horsetown beds rest directly on metamorphic rocks. The 10,000 feet of Knoxville beds in the Cold fork section consist of dark crumpled shales with thin calcareous and sandy bands, and several heavy local beds of coarse conglomerate, the whole resting unconformably on metamorphic rocks of probably Carboniferous age. The basal bed at one place is a coarse conglomerate, and at another point in the same neighborhood it is a shale. The strata all have a steep dip, often nearly or quite vertical.

The only fossils found were in the upper part of the Knoxville. Near Stephenson's house *Aucella crassicollis* is quite abundant, and almost on the strike of this bed, five-eighths of a mile up a small ravine that comes in from the northwest, some thin, slightly calcareous layers yielded the following species:

Pentacrinus sp.
Rhynchonella sp.
Terebratella californica.
Terebratula sp.
Ostrea sp. cf. skidegatensis.
Lima multilineata.
Pecten californicus?
Spondylus fragilis.
Aucella crassicollis.
Myoconcha americana.
Arca textrina.
Pectunculus ? ovatus.
Leda glabra.
Opis californica.
Cyprina occidentalis.
Astarte californica.
Solecurtus ? dubius.
Corbula filosa.
Helcion granulatus.
Fissurella bipunctata.
Pleurotomaria sp.
Turritella sp.
Cerithium sp.
Belemnites impressus.

The beds overlying the Knoxville here form a continuous section up to and including the Chico, but it was not studied in detail and only a few fossiliferous horizons were found. One of these is a limestone, believed to be within the Horsetown beds, a half mile or more across the strike from the Aucella locality. It yielded numerous specimens

[1] Am. Jour. Sci. (3), Vol. XL, 1895, p. 476; Bull. Geol. Soc. Am., Vol. II, p. 207; vol. 4, pp. 205–224; vol. 5, pp. 435–464 (the last a joint paper).

[2] ...ol. Soc. Am., Vol. IV, pp. 245–256.

of *Modiola major*, *Fusus ?* sp., and a few examples of a *Lucina ?* and an Olcostephanus related to *O. deansii* Whiteaves.

On Elder Creek, 15 miles south of the Cold fork of the Cottonwood, Messrs. J. S. Diller[1] and J. Stanley-Brown have measured a section that shows the enormous thickness of 30,000 feet of Cretaceous strata, of which about 20,000 feet are assigned to the Knoxville. The following descriptive notes on this section are by Mr. Diller[2]:

In the Knoxville beds shales predominate, although there are a large number of thin sandstones interstratified with the shales. The great majority of these sandstones are less than a foot in thickness, and they rarely, if ever, attain 10 feet along the north fork of Elder Creek. Sandstones are most abundant in the lower half of the Knoxville; in the upper half they are uncommon. Both north and south of Elder Creek the Knoxville beds contain thick strata of conglomerate, which do not appear in the measured section. The base of the section is serpentine, which has resulted from the alteration of an eruptive rock, in all probability belonging to the peridotites. Ripple marks have been found in this portion of the section, showing that the rocks were deposited in shallow water.

The shales of the Knoxville beds, with occasional thin layers of sandstone, continue upward without any interruption either in the character of the sediments or in the position of the strata into the Horsetown beds. On account of the gradual transition in all respects from the Knoxville to the Horsetown beds, it is impossible to draw a sharp line between them. Aucella being the most abundant, widely distributed, and characteristic fossil of the Knoxville beds, it seems best to draw the line upon a paleontological basis at the upper limits of the Aucella-bearing layers. At that horizon fossils are usually abundant.

The Horsetown beds [about 6,000 feet thick] in this section are composed chiefly of shales, although there are some sandstones of considerable size. One was observed 50 feet in thickness, another 12 feet, and a third 8 feet. Few fossils were found in these beds along Elder Creek, but a short distance to the southward, in the Bald Hills, immediately above the Knoxville, they are more fossiliferous. Several miles east of Lowreys, on Elder Creek, the basal portion of the Chico is rich in fossils. Here is found an intermingling of numerous Chico and Horsetown forms.

The Chico, which has a thickness of nearly 4,000 feet in this section, is composed chiefly of sandstones and conglomerates. The basal portion is made up of conglomerates altogether. The upper portion for 1,100 feet is composed chiefly of shales, and there are some shales lower down intercalated between the sandstones and conglomerates. The conglomerates at the base contain numerous nodules of limestone which are rich in fossils.

Few fossils were found in either the Knoxville or the Horsetown along the line of the measured section. About 5,000 feet above the base of the section the typical variety of *Aucella piochii* is abundant, and some 8,000 feet higher the following fossil plants, identified by Prof. W. M. Fontaine, were collected:

Angiopteridium canmorense (?).
Glossozamites klipsteini.
Pecopteris strictinervis (?).
Thyrsopteris rarinervis (?).
Nageiopsis longifolia (?).
Sagenopteris sp.
Cephalotaxopsis sp.
Cladophlebis inclinata (?).
Osmunda dicksonoides (?).
Angiopteridium strictinerve (?).
Angiopteridium nervosum (?).
Aspidium dunkeri (?).
Aspidium heterophyllum.
Aspleniopteris pinnatifida (?).
Thinnfeldia variabilis (?).

[1] Am. Jour. Sci. (3), Vol. XL, p. 476; republished in somewhat detailed form, with lists of fossils, in Bull. Geol. Soc. Am., Vol. V, pp. 439–440.

[2] Bull. Geol. Soc. Am., Vol. V, pp. 440–441.

The collection was not large and the material was not very well preserved; consequently few positive identifications could be made. The species to which they are doubtfully referred are all from the Lower Cretaceous.

Higher in the Knoxville, 4,000 to 5,000 feet above the plant horizon, *Lytoceras batesi*, *Desmoceras* sp., and *Belemnites impressus* were collected.

No thoroughly characteristic Horsetown species were obtained in the section, but in the lower 1,500 feet of the Chico the following species were collected:

Pecten operculiformis.
Exogyra parasitica.
Cucullæa truncata.
Nemodon vancouverensis.
Pectunculus veatchi.
Trigonia evansana.
Trigonia leana.
Meekia sella.
Coralliochama orcutti.
Chione varians.
Caryatis nitida.
Thetis annulata.
Tellina ashburneri.
Tellina parilis.
Dentalium stramineum.
Lunatia avellana.
Gyrodes expansa.
Anchura falciformis.
Anchura californica.
Cinulia matthewsoni.
Actaeon inornatus.
Desmoceras jugale ?.

A still higher horizon yielded *Inoceramus whitneyi* and *Pachydiscus newberryanus*.

The Horsetown and the Knoxville are both much better represented paleontologically just south of the section in the area extending from the north fork of Elder Creek to Paskenta, a distance of 10 miles. A large proportion of the species described beyond are from this area, which may really be regarded as a part of the Elder Creek section, since the general strike of the beds is nearly north and south, and some of the horizons may be easily traced for long distances. On the south fork of Elder Creek, near Cooper's, which is about 5 miles southwest of Lowreys and not more than 4 miles south of the measured section, there are good exposures of the strata 2,000 to 3,000 feet below the top of the Knoxville. Calcareous bands and concretions in the shales at the lower horizon mentioned contain numerous specimens of *Aucella piochii*, with occasional specimens of *A. piochii* var. *ovata* and an abundance of fossil wood. There were also obtained here Pecten sp., *Lucina ovalis* (?), *Hoplites storrsi*, *Phylloceras knoxvillensis*, fragments of *Lytoceras batesi*, or a closely related species, and Belemnites. A little higher in the same section a heavy bed of sandstone, forming a high ridge, yielded *Aucella piochii* and variety with imperfect specimens of a Perisphinctes. In the overlying shales, about 1,000 feet above the horizon of *Hoplites storrsi*, *Aucella piochii* var. *ovata* and *Belemnites tehamaensis* are abundant. *Aucella crassicollis* and *Inoceramus ovatus* were collected here also; *Hoplites dilleri* comes from near this horizon—perhaps a little lower—some 3 miles to the northward.

The locality 3 miles northwest of Paskenta, which will be frequently mentioned in the descriptions of species, is 4 or 5 miles south of Cooper's

and on approximately the horizon from which *Hoplites storrsi*, *Phylloceras knoxvillensis*, etc., were obtained. Here, in the midst of shales with *Aucella piochii*, there is a mass of limestone about 10 feet thick and not much more than 100 feet long. It has yielded the following species:

Rhynchonella schucherti.
Aucella piochii.
Aucella piochii var. ovata.
Nucula gabbi.
Nucula storrsi.
Lucina ovalis.
Lucina colusaensis.
Cardiniopsis unioides.
Solemya occidentalis.
Corbula persulcata.
Turbo paskentaensis.
Amberleya dilleri.
Hypsipleura occidentalis.
Cerithium paskentaensis.
Phylloceras knoxvillensis (?).
Belemnites sp. Fragments.

Almost directly across the strike from this place, in beds about 2,000 feet higher, the following were collected:

Aucella crassicollis, var.
Desmoceras californicum.
Hoplites crassiplicatus.
Hoplites dilleri.

This is the locality on McCarty Creek, one-fourth mile east of Henderson's.

The other localities between Elder Creek and Paskenta at which Knoxville fossils other than Aucella have been collected are all on approximately the same horizon, very near the upper limit of the Knoxville beds, and separated from each other along the strike by intervals of about 1 mile. Beginning at the north, the first is 2 miles south of Lowreys, where the following species were obtained:

Aucella crassicollis.
Anomia senescens.
Aporrhais sp., related to Helicaulax [?] bicarinata.
Desmoceras sp.
Lytoceras batesi.
Olcostephanus trichotomus.
Crioceras latus.
Belemnites impressus.

A mile farther south a small limestone exposure and adjacent shales yielded:

Aucella crassicollis.
Nucula gabbi.
Solemya occidentalis (?).
Astarte trapezoidalis.
Turbo ? humerosus.
Turbo trilineatus.
Olcostephanus mutabilis.

The next locality southward is on Wilcox's ranch and immediately east of it, where the uppermost layers of the Knoxville contained:

Aucella crassicollis.
Desmoceras sp.
Olcostephanus mutabilis.
Lytoceras batesi.[1]
Sagenopteris mantelli.[2]
Pterophyllum californicum.[2]

In this neighborhood the lower 200 feet of the Horsetown beds are fossiliferous, containing many species that are characteristic of the

[1]This species was not collected in the same layers with the other species, but, from the locality given, must have come from a somewhat lower bed.

[2]These two species of plants were directly associated with Aucella. The Pterophyllum is a new species, named by Professor Fontaine; see Bull. Geol. Soc. Am., Vol. V, p. 450.

Lower Horsetown on the north fork of Cottonwood Creek. The following were collected:

Pecten operculiformis.
Plicatula variata.
Nemodon vancouverensis.
Pleuromya papyracea.[1]
Potamides diadema.
Helicaulax [?] bicarinata.
Lunatia avellana.
Actæon impressus.
Phylloceras onoensis.[2]
Lytoceras batesi.
Olcostephanus traski.
Olcostophanus sp.
Crioceras percostatus.
Crioceras latus.
Belemnites impressus.

This list contains several species that also occur in the Knoxville, but the general assemblage of forms is characteristic of the Horsetown. It shows the close relationship of adjacent portions of the two faunas.

The only other locality in this area to be mentioned is a little farther south, on Shelton's ranch, 5 miles north of Paskenta. Small exposures in a hill one-fourth mile northwest of Shelton's house yielded the following Upper Knoxville species:

Pentacrinus sp.
Cidaris? sp. Fragments.
Avicula whiteavesi.
Aucella crassicollis.
Pinna sp.
Arca textrina (?).
Arca tehamaensis.
Leda glabra.
Astarte corrugata.
Dentalium californicum.
Hypsipleura gregaria.
Cerithium strigosum.
Olcostephanus mutabilis.
Hoplites angulatus.
Belemnites impressus.
Belemnites sp.

It is not necessary to mention the numerous localities within this area where Aucella has been found, since they occur in abundance at most of the Knoxville exposures. Notes on the range of the different species and varieties of Aucella will be found on pages 40–41, 44, 46.

COLUSA COUNTY, CAL.

The Cretaceous strata extending southward from Tehama County through Glenn, Colusa, Lake, and Napa counties, all belong to a single area, interrupted only by occasional eruptive masses or by a covering of more recent formations, though no detailed sections including all the divisions of the Cretaceous have been studied here. In the neighborhood of Wilbur Springs, on Sulphur Creek, Colusa County, there is a great thickness of Knoxville beds. There has been considerable local disturbance of the strata by folds and faults, and I was not able to find, during a brief examination of the area, either the base or the top of the series. On the hill immediately south of Wilbur Springs there is a bed of white limestone, a few feet in thickness, closely associated with a serpentine mass. The limestone[3] is very fossiliferous,

[1] This form has been referred to *P. lævigata* Whiteaves in my previous papers. Gabb's name has priority.

[2] See p. 74.

[3] A few fossils from this locality were described by Gabb in Palæont. of Cal., Vol. II, and it is mentioned, with brief notes on the geology of the region by Becker, in Mon. U. S. Geol. Surv. Vol XIII, p. 367.

Rhynchonella whitneyi being the most abundant species. The list of fossils obtained here is as follows:

Rhynchonella whitneyi.	Turbo wilburensis.
Modiola major.	Turbo colusaensis.
Pecten complexicosta.	Turbo ? humerosus.
Lucina colusaensis.	

The strata in contact with the limestone are not exposed for some distance, but shales and sandstones not far away across the strike on either side contain *Aucella piochii*. The species was found in the sandstone across a ravine from the Manzanita mine and at other localities west of that place; also in the shales on Sulphur Creek, less than one-half mile east of the limestone. The general dip of the rocks on either side is away from the limestone and the associated serpentine. While it is not now possible to assign this limestone to its exact position within the Knoxville beds, there can be no reasonable doubt of its Knoxville age.

On Bear Creek, near the mouth of Sulphur Creek, about a mile east of Wilbur Springs, *Aucella piochii* is very abundant, associated with *Phylloceras knoxvillensis* (?) and Belemnites. Still farther east there are thick beds of coarse conglomerate.

The following species from Colusa County described by Gabb in Palæontology of California, vol. 2, which may possibly belong to the Knoxville fauna, have not been included in this paper:

Palætractus crassus.	Ringinella polita.
Cordiera mitræformis.	Liocium punctatum.

The locality is given as south of road from Colusa to Hot Sulphur Springs, in the first range of foothills, and it is also stated that *Atresius liratus*[1] is associated with them. This species is included in the Knoxville because it has since been found associated with characteristic fossils of that formation, but the others are omitted until something more is learned of their stratigraphic occurrence. They are suggestive of a much later age. *Cordiera mitræformis* appears to be very closely related with *Scobinella dilleri* White[2] from the Chico, and I have identified an abundant small form in the Upper Horsetown with *Liocium punctatum*.

LAKE AND NAPA COUNTIES, CAL.

A few miles south of Sulphur Creek, in the eastern part of Lake County, *Aucella piochii* and *A. piochii* var. *ovata* occur abundantly in a coarse conglomerate. *Phylloceras knoxvillensis* (?) and *Belemnites* sp. also occur here. The locality is in the first ridge south of Cache Creek and about 5 miles north of Palmer's ranch, which is in Morgan Valley midway between Lower Lake and Knoxville. Above (south of) this ridge there are alternations of shales, conglomerates, and crystalline rocks, followed by unaltered shales and sandstones. Whether the

[1] Op. cit., p. 174.

[2] Bull. U. S. Geol. Surv. No. 51, p. 25, Pl. IV, figs. 1–3.

crystalline rocks form dikes or are interbedded eruptives was not determined. At a locality 1 mile northwest of Palmer's, and therefore apparently several thousand feet above the fossiliferous conglomerate, with *Aucella piochii*, Mr. Jasper Palmer, jr., collected the following species in a white limestone:

Pecten complexicosta.	Turbo morganensis.
Astarte trapezoidalis.	Atresius liratus.

Numerous specimens of *Aucella crassicollis* were collected from concretions in the shales near by, making it reasonably certain that the horizon is near the top of the Knoxville. It is probable that this is the "Morgan Valley" locality mentioned by Gabb, from which he obtained *Pecten complexicosta* and *Modiola major*.

The geology of a small area surrounding the village of Knoxville, in northern Napa County, has been described and mapped by Dr. Becker.[1] The strata are highly disturbed, so that the details of the stratigraphy have not been thoroughly determined, though the sedimentary rocks are all referred to the Knoxville division. Both *Aucella piochii* and *A. crassicollis* occur in the neighborhood, sometimes near each other, but not associated in the same stratum. It is reasonable to infer that the two forms here have the same stratigraphic relation to each other that they are known to have in regions where the structure is more simple. Other fossils are rare, the only determinable species being *Belemnites impressus* and young specimens of *Phylloceras knoxvillensis*. Dr. White also reports[2] *Ammonites ramosus* (?), *Potamides diadema* (?), *Lima shastaensis* (?), Margarita (?), Dentalium, Arca, Nuculana, and Rhynchonella. The first of these is now referred to *Phylloceras knoxvillensis*, the second may be *Amberleya dilleri*, and the others are too imperfect for identification.

MOUNT DIABLO AND OTHER LOCALITIES SOUTHWARD.

Knoxville beds occur in the neighborhood of Mount Diablo, east of San Francisco. The area has been studied and described somewhat in detail by Mr. H. W. Turner,[3] and according to his map and section the Knoxville appears only on the northern and northwestern sides of the peak, where it is in contact with metamorphic and eruptive rocks. Lithologically the beds have the usual character, consisting of dark shales interstratified with thin arenaceous and calcareous layers. They are well exposed in the canyon of Bagley Creek, where, near the contact with the eruptive area, *Aucella piochii* has been collected by several parties, including the writer. At other localities in the vicinity Mr. Turner obtained fragmentary specimens of Belemnites, Inoceramus, and a few other indeterminate forms. The thickness of the Knoxville in this area has not been well determined, on account of the difficulty in fixing its upper limits in the local section. The fossils that have

[1] Mon. U. S. Geol. Surv. No. XIII, pp. 271–290.
[2] Bull. U. S. Geol. Surv. No. 15, p. 20.
[3] Bull. Geol. Soc. Am., Vol. II, pp. 383–402.

been found in it are all in the lower portion, and there is a thickness of several thousand feet of overlying strata, in which no fossils have yet been found. On the line of a section northward from the Aucella locality on Bagley Creek the next fossiliferous horizon seen was in the upper part of the Chico, where *Baculites chicoensis* and a few other characteristic Chico fossils were found, only a few hundred feet below beds of Tejon (Eocene) age. The intervening strata, which are mostly covered, I estimated to be about 5,000 feet thick.

A large part of their thickness belongs to the Chico, for the exposure south of Mount Diablo yielding *Trigonia evansana*, *Nemodon vancouverensis*, *Anchura californica*, *Baculites chicoensis*, *Acanthoceras turneri*, etc., represents a low horizon in that formation, which Mr. Turner estimates to be nearly 6,000 feet thick in this vicinity. The thickness of the Chico is well shown along the railroad northeastward from the arsenal near Benicia, a few miles north of Mount Diablo. In that section the Chico can not be less than 3,000 or 4,000 feet thick.

Whether the strata lying between the Chico and the horizon of *Aucella piochii* include representatives of all the Knoxville beds with *Aucella crassicollis*, as well as of the Horsetown beds, is one of the questions yet to be answered. If the horizons are all represented, then sedimentation was here very much less rapid during a part of the Cretaceous than it was 150 miles north, in Tehama County; while if the Horsetown and a part of the Knoxville beds are really lacking, there must have been a local uplift of the Mount Diablo region which did not involve the coast ranges farther north, where Mr. Diller has shown that there was continuous sedimentation from the Knoxville to the Chico, inclusive. It is an interesting fact in this connection that the Horsetown fauna has not been found well developed any place south of Tehama County, though it doubtless will be found in the unstudied areas immediately south of that county. The reported occurrence of *Lytoceras batesi* at Benicia and south of Mount Diablo has been cited as evidence that the Horsetown beds are probably present there, but Gabb distinctly credits these specimens to the Chico.[1] It is probable that they belong to a somewhat similar but distinct species that has recently been found in the Chico on Cow Creek, Shasta County.

The presence of the Knoxville near the shore of San Francisco Bay is attested by the occurrence of *Aucella piochii* just north of Berkeley, at a locality pointed out to me by Prof. A. C. Lawson, of the State University.

Through the kindness of Prof. James Perrin Smith, of Stanford University, I have been allowed to examine specimens of *Aucella piochii* and Belemnites from a locality 7 miles east of San Jose,[2] and others

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[1] Palæont. Cal., Vol. II, p. 211.

[2] Bull. Geol. Soc. Am., Vol. V, p. 257. Professor Smith compared these forms with the Russian species *Aucella mosquensis* and *A. trigonoides*, and concluded that they are probably of Jurassic age, older than the Knoxville series. He states that those from the first-named locality are from the "metamorphic phthannite series." On comparing the fossils I could not see any reason for separating them from the Knoxville forms.

that seem to belong to *Aucella piochii* var. *ovata*, from Stevens Creek Canyon, 13 miles from Mountain View, Cal.

At the most southerly known locality of the Knoxville beds, in the Santa Lucia range, 5 miles west of Santa Margarita, San Luis Obispo County, Mr. Turner[1] and Mr. Fairbanks[2] have collected *Aucella piochii*, and at other localities in the same county, on Toro Creek and Pine Mountain, the latter gentleman obtained *Aucella crassicollis*, indicating that at least two Knoxville horizons are represented in that region.

RIDDLES, OREG.

This locality is in southeastern Oregon, on Cow Creek, near its junction with the south fork of Umpqua River. The Cretaceous rocks here, covering an area about 5 miles long by 3 miles wide, are in contact with metamorphic rocks on the east and with serpentine and peridotite on the west. The strata at most exposures have a steep dip and seem to form a syncline, complicated perhaps by faults or minor folds. Small faults are seen at many exposures. The rocks consist of shales and sandstones, with heavy beds of coarse conglomerate, especially near the base, and with thinner calcareous bands.

Some of the exposures in the central portion of the area, as on the banks of Cow Creek just below the bridge at Riddles and in the first low ridge east of the creek, a short distance above the town, are very fossiliferous, yielding a number of species characteristic of the Horsetown beds, with some new forms that have not been seen elsewhere.

The following, with some other undetermined species, were obtained here:

Pentacrinus sp.
Rhynchonella sp.
Pecten operculiformis.
Nemodon vancouverensis (=Arca breweriana).
Trigonia aequicostata.
Trigonia leana (?).
Opis sp.
Eriphyla sp.
Cardium (Protocardia) sp.
Pleuromya papyracea (=P. lævigata).
Helicaulax [?] bicarinata.
Lytoceras batesi.
Lytoceras sp.
Olcostephanus traski.
Hoplites sp.
Belemnites impressus.

The same bed has yielded the following species of plants, identified by Professor Fontaine, who states that they indicate the Horsetown age:

Nageiopsis latifolia.
Angiopteridium nervosum.
Angiopteridium oregonense n. sp.[3]

At the second locality mentioned above, the stratum containing this assemblage of forms is not more than 150 feet above shales containing *Aucella crassicollis*, so that it is very near the base of the Horsetown. This is precisely the position that is indicated by the fauna, which is

[1] Mon. U. S. Geol. Surv. Vol. XIII, p. 381, 1888.
[2] 13th Rept. Cal. State Mineralogist, p. 512, 1894.
[3] Not yet described.

largely identical with that of the basal Horsetown beds, on the north fork of Cottonwood Creek and in Tehama County, Cal. On the road to the nickel mines, west of Riddles, a sandstone exposure yielded *Trigonia æquicostata,* Eriphyla sp., *Pleuromya papyracea,* and a few others of these Horsetown species. This exposure apparently lies between others not far away in which *Aucella crassicollis* is abundant, and if the beds are in their normal relation to each other there is here an alternation of Aucella beds with the Horsetown fauna such as has not been seen elsewhere. It is more probable, however, that these beds have been brought into their present position by faulting or folding, as there are sudden changes in dip and other evidences of local disturbance in the immediate neighborhood. In one of these upper Aucella beds on the road to the nickel mines, 2 or 3 miles west of Riddles, Mr. W. Q. Brown obtained the type of *Hoplites hyatti* in immediate association with *Aucella crassicollis.*

The lower Knoxville beds of the Riddles area contain *Aucella piochii* and its variety *ovata.* This species is found near the base of the series, where it rests (probably unconformably) on the metamorphic rocks in the hills southeast and east of Riddles; also along the railroad on the banks of Umpqua River about 2 miles north of Riddles. It also occurs on the bank of Cow Creek one-half mile below the town, where the beds containing it are probably brought up by faulting.

The Knoxville beds are also well exhibited along the south fork of Umpqua River below the mouth of Cow Creek, where a thickness of several thousand feet is exposed and many of the beds are full of *Aucella crassicollis.*

In discussing the relations of the Knoxville and Horsetown beds Mr. Becker[1] has mentioned these localities near Riddles and has published a list of fossils essentially the same as the one given above (with some changes in the nomenclature), excepting that he regards Aucella as an associate of the Horsetown fossils mentioned. Mr. Diller,[2] who has visited the locality several times, and has briefly described the structure of the area, has expressed similar views concerning the relations of the fossils, though he states that he has "never been able to obtain Aucella and Horsetown fossils from exactly the same exposure." After visiting the locality and studying the collections made there by Messrs. Becker, Brown, Diller, and the writer, I am confident that Aucella has not been found associated in the same stratum with the Horsetown fauna. I think it is safe, therefore, to interpret this section as agreeing with those in Tehama County, where the Horsetown beds rest conformably on the Knoxville and the faunas are essentially distinct, though having some species in common. When the structure of the area is worked out in detail with the aid of paleontology the anomalies in the distribution of some of the beds will doubtless be explained.

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[1] Bull. Geol. Soc. Am., Vol. II, pp. 203-205.
[2] Ibid., p. 208; Vol. IV, p. 212.

LOCALITIES IN WASHINGTON.

The presence of Knoxville beds in Washington is inferred from the occurrence of bowlders containing *Aucella crassicollis* near Seattle and Tacoma,[1] and also from the fact that Aucella beds are well developed in British Columbia immediately north of Washington.

THE FAUNA OF THE KNOXVILLE BEDS.

In the description of the species, forming the principal part of this paper, 77 species and varieties of invertebrates are enumerated. They have also been named in the local lists on the preceding pages. Of these 77 species, 50 are described as new, 12 have been described in previous publications, and the remainder are simply referred to genera because the material at hand is insufficient for specific diagnoses. All but 7 of the species are Mollusca, including 33 species of Pelecypoda, 1 species of Scaphopoda, 18 species of Gastropoda, and 18 species of Cephalopoda, of which 15 are Ammonoids and 3 are Belemnites. The other 7 species include 5 Brachiopoda and 2 Echinodermata (1 Crinoid and 1 Echinoid).

The very large proportion of new species will doubtless seem remarkable, but it should be remembered that the majority of them are comparatively rare, and the great abundance of Aucella, usually without any associates, has doubtless discouraged careful search for fossils. In the last few years, however, the discussions concerning the age of the Knoxville beds and their importance in the geology of the Pacific Coast have attracted attention to them. Mr. Diller and other geologists working in that region have therefore made special efforts to find other fossils associated with Aucella. The result has been the addition of an almost entirely new fauna to the Cretaceous of the Pacific Coast, though it is evident that we know, as yet, only a fraction of the fauna that existed during the Knoxville epoch. This is shown by the fact that almost every locality for fossils discovered in the Knoxville beds yields a group of new species. Only Aucella is distributed throughout the horizontal and vertical extent of the series.

When studying the Knoxville fauna as a whole, either in the field or from average collections, one is impressed with the excessive preponderance of the Aucellæ, so far as number of individuals is concerned. In many places they are so abundant that they must have actually monopolized the sea bottom, crowding out everything else.

Considering the fauna as an assemblage of species the proportion of Brachiopoda, though there are so few, is somewhat greater than in other American Cretaceous faunas. Among the Mollusca the variety of forms of Turbinidæ is noteworthy. The proportion of Ammonoids is also quite large, and there is an unusual development of the genus Hoplites.

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[1] See J. S. Diller, Cretaceous and Early Tertiary of Northern California and Oregon, Bull. Geol. Soc. Am., Vol. IV, p. 217.

RELATIONSHIP WITH OTHER FAUNAS.

The local lists of fossils on preceding pages show that the later portions of the Knoxville fauna are quite closely connected with the succeeding Horsetown fauna, several species passing from the one to the other. The general assemblage of forms, however, is sufficiently different for their easy recognition.[1]

The fauna of the Mariposa beds on the western slope of the Sierra Nevada in central California resembles the Knoxville more closely on account of the occurrence of Aucellæ in it. Dr. White[2] referred these Aucellæ and those of the Knoxville to the same species, and regarded the Mariposa and the Knoxville as contemporaneous. Further studies have shown that while the Aucellæ from the two formations in some varieties resemble each other quite closely, they can usually be distinguished.

The Ammonites and other fossils from the Mariposa beds, so far as they are known, are entirely distinct from those of the Knoxville. Professor Hyatt says on this point, after examining nearly all of the Knoxville Ammonites here described, that "the fauna of the entire gold belt [Mariposa] series of slates have nowhere been found to contain a species similar to those of the numerous Ammonitinæ found in the Cretacic faunas of the Upper Knoxville and Shasta groups."[3] He lists and describes the following species from the Mariposa beds:

Cardioceras dubium.
Cardioceras beaugrandi.
Perisphinctes virgulatiformis.
Perisphinctes sp.
Perisphinctes sp.
Perisphinctes filiplex (?).
Perisphinctes colfaxi.
Perisphinctes mühlbachi.
Olcostephanus lindgreni.
Œcotraustes denticulata.
Belemnites pacificus.
Avicula sp.
Amusium aurarium.
Aucella erringtoni.
Aucella elongata.
Aucella aviculæformis.
Aucella orbicularis.

The beds are referred in part to the Upper Oxfordian and correlated with the Russian zone of *Cardioceras alternans*. Prof. J. P. Smith[4] reached essentially the same conclusion concerning the age of these beds. The Mariposa is therefore regarded as older than the Knoxville. The two faunas have never been found in the same section so that their relative stratigraphic positions could be determined, the Mariposa being confined to the Sierra Nevada and the Knoxville to the Coast ranges.

Aucella-bearing strata are reported to occur near Catorce, in the State of San Luis Potosi, Mexico, by Nikitin[5] and by Aguilera and Ordoñez.[6] This locality is much farther east as well as farther south

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[1] The larger part of the Horsetown fauna is illustrated by Gabb in the Palæontology of California. Nearly all of the species listed in the second volume from the "Shasta group, north fork of Cottonwood Creek" belong to this fauna.

[2] Bull. U. S. Geol. Surv. No. 15, p. 24.

[3] Bull. Geol. Soc. Am., Vol. V, p. 408.

[4] Bull. Geol. Soc. Am., Vol. V, pp. 251–256.

[5] Neues Jahrb. für Min. Geol. und Palæont., Bd. II, 1890, p. 273.

[6] Datos para la Geologia de Mexico, 1893.

than any other place at which Aucella has been found on the mainland of North America. In both papers the strata are referred to the Jurassic, and the Aucellæ are identified with Russian species.

During the present year Castillo and Aguilera[1] have published an important paper in which the fauna of the Mexican Aucella-bearing beds is described and illustrated. The strata of the Catorce region are lithologically divided into three groups, which are thus described, beginning at the base:

1. Metamorphic clay slates without fossils.

2. Alternating beds of sandstone and marly and argillaceous shales, very rich in fossils.

3. Compact gray ash-colored more or less siliceous limestones, with nodules and bands of black flint. The lower part of the group is argillaceous and has a slaty structure. Fossils rare.

Of the 65 species and varieties of invertebrates described from this series, 59, including all of the Aucellæ, are from the middle group, in which two divisions are recognized. The lower division of group No. 2 is especially rich in Cephalopoda, of which there are enumerated 16 species of Perisphinctes, 4 of Hoplites, 3 each of Rhacophyllites and Haploceras, 2 each of Aptychus and Belemnites, and 1 each of Nautilus, Olcostephanus, and Aspidoceras. In the upper part of this division Aucella makes its first appearance associated with *Rhynchonella lacunosa*. This form of Aucella is referred to *A. bronni*.

The upper division of No. 2 includes the principal Aucella-bearing bed, in which Messrs. Castillo and Aguilera recognize the following forms of Aucella:

Aucella bronni.
Aucella bronni var. lata.
Aucella pallasi.
Aucella pallasi var. plicata.
Aucella pallasi var. tenuistriata.
Aucella volgensis.
Aucella fischeriana.
Aucella aff. piriformis.
Aucella terebratuloides.

These forms are said to be all found together in a series of beds with a total thickness of 5 meters, which can not be separated into different zones. Associated with Aucella in this division are 1 species each of Lytoceras, Placenticeras [?], Pulchellia, and Olcostephanus.

Aucella does not pass up into the upper group (No. 3 of section), which has yielded a Lucina, an Exogyra, a Phylloceras, and 2 species of Hoplites from the calcareous and marly shales at its base. The limestones of the upper part of No. 3 have yielded but a single species, Schloenbachia [?] related to *S. inflata*.

As to the age of these beds, after weighing the somewhat discordant evidence of the fossils, the authors conclude that the lower division of No. 2 should be referred to the Upper Jurassic, while the upper division of the same group, with the principal bed of Aucella, is regarded as

[1] Boletin de la Comision Geológica de Mexico, num. 1. Fauna de la Sierra de Catorce, San Luis Potosi, Mexico, 1895.

Neocomian. The upper member of the series is thought to represent the upper portions of the Lower Cretaceous, viz, the Aptian and the Albian.

On comparing this Mexican fauna with that of the Knoxville beds the principal points of resemblance are found in the Aucellæ and a few of the Ammonites. The forms of Aucella, so far as can be determined from the somewhat unsatisfactory photographic figures, can all be duplicated in the Knoxville. Several of the species of Hoplites are of the same type as *Hoplites storrsi*, and one of them, described as a variety of *H. calisto*, is possibly identical with it. One of the figures of *Olcostephanus potosinus* has sculpture very much like that of *O. mutabilis*, and *Placenticeras fallax*, although referred to a different genus, seems to be related to *Phylloceras knoxvillensis*. All of these, excepting a part of the Hoplites, are from the upper division of No. 2 of the section. It is reasonable, therefore, to conclude that this portion of the Catorce section is of the same age as part of the Knoxville. The lower fauna, characterized by a large number of species of Perisphinctes, is very probably older than the Knoxville, and perhaps should be compared with the fauna of the Mariposa beds, though there is a noteworthy absence of species of Cardioceras and several other genera of Ammonites that are characteristic of the Mariposa.

It is a remarkable fact that the fauna of the Catorce region contains none of the characteristic forms of the Texan Lower Cretaceous, which is known to cover a large part of Mexico. Its relations seem to be entirely with the boreal and Pacific faunas, although the locality is far east of the present Pacific drainage and directly south of the Texan Cretaceous area. Lithologically the upper limestones of the Catorce section seem to resemble those of the Texan Comanche series, but so far only a single species has been found in them. Further detailed studies in this portion of Mexico will probably yield data for the more satisfactory correlation of the Lower Cretaceous of the Pacific Coast with that of the Texan region, and they will certainly throw much light on an important epoch in the history of the continent.

Dr. J. Felix[1] has described a small fauna from beds that are referred to the Neocomian in Oaxaca, southern Mexico. Among the fossils are several species of Hoplites that appear to be rather closely related to some of those in the Knoxville beds. None of the species is identical, however, and too little is known of the fauna to warrant its correlation with the Knoxville.

It has already been stated that beds of the same age as the Knoxville occur in British Columbia, both on the mainland and on Vancouver and Queen Charlotte islands. This fact is fully shown in the paleontological writings of Mr. J. F. Whiteaves,[2] though few of the species other than *Aucella crassicollis* and *Belemnites impressus* seem to

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[1] Palæontographica, Bd. XXXVII, 1891, pp. 180–189.

[2] Geol. Surv. Canada, Mesozoic Fossils, Vol. I, pts. 1 and 3, 1876 and 1884; Trans. Roy. Soc. Canada, Vol. I, 1882, Sec. IV, pp. 81–86; Cont. to Canadian Palæont., Vol. I, pt. 2, 1889.

be identical with Knoxville species in California. Some of the Canadian localities for *A. crassicollis* are enumerated on page 47. While the existence of the Knoxville in British Columbia is thus established, none of the formations or divisions recognized by the Canadian geologists is strictly its equivalent, and for that reason it is not practicable to determine how many of the described species really belong to the fauna of the Aucella beds. In a previous paper[1] evidence has been given that the Queen Charlotte formation includes strata belonging to both the Horsetown and the Knoxville and possibly still older beds.

Aucellæ have been found at several places in Alaska, and have been described and figured by Eichwald,[2] White,[3] and Fischer.[4] More recently the United States National Museum has received Aucella and associated forms from other Alaskan localities through the United States Fish Commission steamer *Albatross*, and Mr. W. J. Fisher, of Kodiak, Alaska. Taken altogether, the collections indicate that there are several horizons in the Alaskan Aucella beds, some of which are probably older than the Knoxville, and to be compared rather with the Mariposa. For example, Aucellæ from several localities on Shelikof Strait, south of the Alaskan Peninsula, closely resemble *Aucella erringtoni* or *A. bronni*. Many of those from Herendeen Bay, associated with a large Pecten and *Belemnites æquilateralis* Eichwald (?), seem to be identical with the Russian Jurassic *Aucella pallasi;* while other specimens from the same bay, but apparently from a different bed, are referable to the Cretaceous species *A. crassicollis*. The latter species also occurs at Port Möller. None of the other species collected in Alaska is represented in the California Knoxville.

Other faunas with which the Knoxville should be compared are those of circumpolar distribution, characterized by an abundance of Aucella,[5] and most thoroughly known in Russia. The Aucellæ have been monographed by Lahusen[6] and the Ammonites have been described in various papers by Nikitin, Michalski, Pavlow, and others, so as to be available for comparison. In that region Aucella ranges from the zone of *Cardioceras alternans* up through the Lower and Upper Volgian and the Petschora beds. In the lowest zone mentioned, both the Ammonites and the Aucellæ are closely related to those in the Mariposa beds, while the Petschora forms of Aucella are either identical or very closely related with those of the Upper Knoxville, and the Ammonite faunas are also similar, so far as they are known. An upper portion of the Knoxville may be considered the taxonomic equivalent of the Petschora beds, of course without predicating contemporaneity. The work of Professors Smith and Hyatt, comparing part of the Mari-

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[1] Bull. Geol. Soc. Am., Vol. V, pp. 445, 446.

[2] Geognost. Beobachtungen über die Halbinsel Mangischlak und die Aleutischen Inseln.

[3] Bull. U. S. Geol. Surv. No. 4.

[4] In Pinart's Voyage à la côte nordouest de l'Amérique.

[5] For further details on the distribution of Aucella, see p. 40.

[6] Mém. du Comité géologique, Vol. VIII, No. 1, St. Petersburg, 1888.

posa beds with the zone of *Cardioceras alternans*, has already been referred to. The Ammonites of the Lower Volgian as monographed by Michalski[1] show little relationship with those of the Knoxville, indicating, so far as the evidence goes, that the Lower Volgian is older. There would then remain only the Upper Volgian and the Petschorian as the equivalents of the whole of the Knoxville. These are only suggestions, and I do not wish to be understood as making these definite correlations in such widely separated regions on the insufficient data now available. It is hoped that the Russian paleontologists will soon describe the other Mollusca from their Aucella beds, as well as the Aucellæ and Cephalopoda.

The development of the Aucella beds in Russia is not comparable in thickness with that of the Knoxville. In the descriptions of the local sections the total thickness given is usually only a few meters. I have not been able to find any estimates of the maximum thickness.

THE AGE OF THE KNOXVILLE BEDS.

After the above comparisons have been made this subject brings up the much discussed and apparently still unsettled question of the age of the Russian Aucella beds. Opinions have varied, from Eichwald's that they are all Cretaceous, to that of Trautschold and others that they are all Jurassic. I believe that it is now generally accepted that the lower portion is Jurassic and the upper is Cretaceous, but it is still undecided where the line between the two should be drawn. It would be beyond the scope of this paper to review the whole discussion. I will simply quote a few sentences that show the position of some of the present workers in that field.

In 1888 Nikitin made this statement concerning the Volgian:

> Up to the present time the deposits of the Upper and Lower Volgian of Russia and Poland remain isolated and can not be classified with the deposits of western Europe. I have previously stated that the greatest development of the Volgian coincides with the time of the greatest retreat of the sea in central Europe, and, on the contrary, with the time of the greatest development of the southern sea which deposited the marine Tithonian and the marine Neocomian horizons, represented in central Europe by fresh-water and littoral brackish-water deposits.[2]

In his study of the Ammonites of the Lower Volgian, Michalski[3] concludes that the fauna is autochthonous, not at all related to those of western Europe, and remarks:

> As the immediate result of the above considerations, we clearly reach the conclusion that the strata containing our Ammonites are of the same age as some of the Mesozoic strata of western Europe, which in the region near Poland are either entirely lacking (Carpathians) or form a fresh-water facies (northern Germany), that is, that our Lower Volgian beds belong to the Neocomian epoch.

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[1] Mém. du Comité géologique, Vol. VIII, No. 2.

[2] Les Vestiges de la Période Crétacée dans la Russie Centrale, Mém. du Comité géologique, Vol. V, No. 2, p. 191.

[3] Die Ammoniten der Unteren Wolga-Stufe, Mém. du Comité géologique, Vol. VIII, No. 2, p. 486, St. Petersburg, 1894.

Pavlow finds the Russian faunas more closely related to those of western Europe, and makes definite correlations of the different zones. In one of his latest papers[1] he says:

> To my mind the Lower Volgian stage—that is, the Portland of the Boulogne series—and the zones of the Upper Volgian stage of Nikitin (first stage of Rouiller) correspond to the Purbeck, that is, the fresh-water facies of the Upper Portland, for the marine equivalent of which I proposed the name Aquilonian series.

The Petschora beds with *Olcostephanus* (*Polyptychites*) *polyptychus*, *O.* (*Polypt.*) *keyserlingi*, *O. hoplitoides*, *O. decheni*, *Belemnites subquadratus*, *Aucella volgensis*, and *A. keyserlingi* are referred to the lower Neocomian.[2]

It is evident, then, that even if it were possible to refer the Knoxville to definite horizons of the Russian Aucella beds its age might still be questioned. One important fact that should be borne in mind is that structurally and faunally, so far as known, the Knoxville is a unit. It is true that there is a gradual change in the fauna from the lower to the upper beds, but there is no distinct break that would justify the reference of one portion to the Jurassic and another to the Cretaceous. There are some elements of the fauna, such as *Belemnites tehamaensis*, *Hoplites storrsi*, and some of the Turbinidæ, that resemble European Upper Jurassic types. *Aucella piochii* belongs to the same general type as *A. mosquensis*, which has usually been referred to the Jurassic, and it is somewhat closely related to the Aucellæ[3] of the Mariposa beds, but Professor Pavlow informs me that Aucellæ very similar to *A. mosquensis* occur in the Neocomian of Russia also. These resemblances, which will be more fully mentioned in the description of the species, are not considered of sufficient importance to counterbalance the evidence of the Cretaceous age of the entire series. Some Jurassic elements are naturally to be expected in the Lower Neocomian, and it is a well-known fact that in Europe several species of Ammonites pass up from the Jurassic to the lowest Cretaceous beds.

Professor Hyatt's opinion as to the Cretaceous affinities of the Knoxville Ammonites has been cited on a previous page. That the Upper Knoxville beds containing *Aucella crassicollis* are Neocomian is shown by the resemblance of its fauna to that of the Petschora beds, now generally admitted to be Neocomian, and by its stratigraphic and faunal relations with the immediately succeeding Horsetown beds, which have been compared with the Gault by everyone who has studied their fauna.[4] The few fossil plants that have been obtained from the Knoxville and the Horsetown also tend to show that these two formations are

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[1] On the Mesozoic Formations of the Government of Riazan, p. 24, Moscow, 1894. For the translation of this from the Russian I am indebted to Mr. Robert Stein.

[2] Ibid., pp. 21, 22, and French résumé at the end.

[3] See comparisons by Professor Hyatt, Bull. Geol. Soc. Am., Vol. V, pp. 404–407.

[4] It is not probable that the limits of the divisions recognized in the California Cretaceous coincide exactly with those of the European subdivisions of the Cretaceous. It has been shown (Bull. Geol. Soc. Am., Vol. V, pp. 445, 449) that the Horsetown beds probably include the lowest Cenomanian, and at their base they may contain strata older than the Gault.

closely connected, and these plants are mostly either identical or closely related with species in the Lower Cretaceous Potomac formation of the eastern United States and in the Trinity beds at the base of the Comanche series in Texas.[1]

From all these lines of evidence the conclusion is reached that the entire Knoxville series is of Neocomian age.

DESCRIPTION OF THE SPECIES.

ECHINODERMATA.

The only remains of Echinodermata yet found in the Knoxville beds are spines and small fragments of the test of a Cidaris from Shelton's ranch, 5 miles north of Paskenta, Cal., and joints of Pentacrinus columns from the same place and from Stephenson's, on Cold fork of Cottonwood Creek, Tehama County, Cal. These have been placed in the hands of Prof. W. B. Clark, who has in preparation a monograph of the Mesozoic Echinodermata of the United States.

MOLLUSCOIDEA.

BRACHIOPODA.

RHYNCHONELLIDÆ.

Genus RHYNCHONELLA Fischer.

RHYNCHONELLA SCHUCHERTI n. sp.

Pl. I, figs. 1–4.

Shell small, inflated, subtriangular in outline, with the angles rounded and the front slightly emarginated. Ventral valve very convex, with a narrow, strongly incurved beak; pedicle opening small; a shallow, obscure mesial sinus extends nearly two-thirds the length of the valve, becoming deeper and broader toward the front. Dorsal valve considerably shorter and much less capacious than the ventral, and with a much more pronounced mesial sinus, which extends from near the beak to a little beyond the middle as a narrow, shallow sulcus and then abruptly broadens and deepens, so that at the front it is almost one-fourth as wide as the valve; surface smooth, showing only delicate lines of growth and very faint, almost microscopic, radiating lines.

The two figured specimens, which are of about the average size and show the extremes of variation in form and proportion, give the following dimensions: Length, 15 mm.; breadth, 16½ mm.; convexity, 10 mm. Length, 14 mm.; breadth, 15 mm.; convexity, 11 mm.

The crura are somewhat longer than in typical Rhynchonella, in this respect suggesting the Triassic and Jurassic genus Rhynchonellina,

[1] These plants are the only means by which the Lower Cretaceous of Texas and California can be compared. So far as known, their invertebrate faunas have nothing in common.

some forms of which, such as *Rhynchonellina bilobata* Gemmellaro, also resemble this species in external features.[1] The crura are not sufficiently developed, however, to justify placing the species in that genus. The hinge line is short and arched and the shell structure is fibrous. The incurving of the beak of the ventral upon the dorsal valve obscures and partly conceals the small delthyrium, and for that reason the deltidial plates have not been seen.

The specific name is given in honor of Mr. Charles Schuchert of the United States National Museum.

Locality and position.—About 100 specimens have been collected, all from a small lens of limestone, 4 or 5 feet thick, 3 miles northwest of Paskenta, Cal., and about 3,000 feet below the top of the Knoxville beds.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23017.)

RHYNCHONELLA WHITNEYI Gabb.

Pl. I, figs. 5–10.

Terebratella whitneyi Gabb, 1866, Palæont. California, Vol. II, p. 35, pl. 12, figs. 62, 62*a*.
Rhynchonella whitneyi Gabb, 1869, Ibid, p. 204, pl. 34, figs. 105, 105*a*.

Shell large, subcircular in outline, inflated, the two valves being almost equally convex; no median fold nor sinus in either valve; surface ornamented with about 40 to 50 narrow, angular plications, which are equal in breadth to the deep angular interspaces; specimens with the larger number of finer ribs have quite a different aspect from the more coarsely plicate variety.

The form of the shell changes considerably during growth. In the earlier stages it is long, slender, and not very convex, having almost the outline of a Lingula (fig. 5). Smaller specimens are still more slender.

The specimen represented by figs. 7 and 8 shows the typical adult form. It measures 32 mm. in height, the same in breadth, and 21 mm. in convexity. This is perhaps nearly an average in size of the specimens collected, though a few broken specimens were obtained even larger than those represented by figs. 9 and 10.

The species was at first referred to the Tertiary, but before the second publication above referred to Gabb had discovered that it occurred in a limestone included in the Aucella-bearing series. He also pointed out its close resemblance to *R. peregrina* Von Buch, a French Neocomian species.

Locality and position.—The types of the species came from "one mile east of the Excelsior mine, Napa County," and "twenty miles east of Clear Lake, on the road from Colusa to the Hot Sulphur Springs." The latter locality is probably the same as one near Wilbur Springs, on Sulphur Creek, Colusa County, Cal., from which Dr. Becker and Mr. Turner brought back specimens several years ago, and where, in 1894,

[1] See Böse, Mon. des Genus Rhynchonellina, Palæontographica, Bd. XLI, Taf. VII, figs. 30, 31.

I obtained the specimens here figured, and many others. It occurs in great abundance, associated with *Pecten complexicosta*, *Modiola major*, *Lucina colusaensis*, and a few other forms, in a thin bed of white limestone. No Aucellæ are immediately associated with it, but the shales on each side of the limestone a few hundred yards distant contain *Aucella piochii*, and from the structure of the region these strata all seem to belong to one series.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23018.)

RHYNCHONELLA sp.

An apparently undescribed species of Rhynchonella is represented by several fragmentary specimens associated with *Terebratella californica* at the locality, near Stephenson's, on Cold fork of Cottonwood Creek. It is nearly the same size as the Terebratella, but more triangular in outline and marked by about 14 strong plications.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23019.)

TEREBRATULIDÆ.

Genus TEREBRATULA Llhyd.

TEREBRATULA sp.

Pl. I, fig. 11.

Shell of medium size, subovate in outline, moderately convex; sides nearly straight for a little more than half the distance from the beak to the front and diverging at an angle of about 80°; front regularly rounded; beak broad, not very prominent.

Length, 25 mm.; breadth, 24 mm.; convexity of ventral valve, about 5 mm.

The single imperfect ventral valve of this species is all that has yet been found, and it is not worth while to give it a specific name until it can be more fully characterized, though it seems not to be referable to any described American species. Its general form and the punctate character of the test make its generic reference reasonably certain.

Locality.—Near Stephenson's, on Cold fork of Cottonwood Creek, with the following species.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23020.)

TEREBRATELLIDÆ.

Genus TEREBRATELLA d'Orbigny.

TEREBRATELLA CALIFORNICA n. sp.

Pl. I, figs. 12 and 13.

Shell of medium size, suboval in outline, broader than long; cardinal margin sloping gently from the beak, joining the rounded sides by an abrupt curve; front broadly emarginate; ventral valve slightly

more convex than the dorsal, marked by about 28 strong plications, 8 of which are borne on the broad, flat mesial fold; beak moderately prominent, truncated by the large round foramen, beneath which the deltidial plates seem to be well developed; cardinal area broad and elevated.

Dorsal valve nearly flat, with a broad mesial sinus, corresponding to the fold in the ventral valve, extending from about the middle to the front; plications equal in number and similar in arrangement to those on the ventral valve.

The specimens selected for illustration are the largest in the collection. The ventral valve measures 16 mm. in length and 20 mm. in breadth, while the corresponding measurements of the dorsal valve of another individual are 14 mm. and 20 mm., respectively.

None of the valves are united, but they are associated in such a way that there can be no doubt that they belong to the same species, which is represented by 20 more or less imperfect (mostly dorsal) valves. The form of the brachidium is unknown, and the reference of the species to Terebratella is therefore only provisional. The shell is punctate.

Locality and position.—Near Stephenson's, on Cold fork of Cottonwood Creek, Tehama County, Cal., in the upper part of the Knoxville beds.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23021.)

MOLLUSCA.

PELECYPODA.

OSTREIDÆ.

Genus OSTREA Linnæus.

OSTREA sp.

Pl. II, fig. 1.

Cf. *Ostrea skidegatensis* Whiteaves, 1884, Mesozoic Fossils, Vol. I, p. 243, pl. 32, fig. 1, and fig. 12 in text.

Shell of rather small size, irregularly ovate in outline, smooth. Known only from lower valves, which are quite abundant, but usually not well preserved, in the upper part of the Knoxville beds, near Stephenson's, on Cold fork of Cottonwood Creek. As the material at hand does not show any distinctive features by which this form may be distinguished from a number of other so-called species ranging from the Cretaceous to the present time, it does not seem advisable to give it a new specific name.

Some of the specimens are about twice as large as the one figured.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23022.)

ANOMIIDÆ.

Genus ANOMIA Linnæus.

ANOMIA SENESCENS n. sp.

Pl. II, fig. 2.

Shell rather large, subcircular in outline, slightly oblique, depressed convex; hinge line straight, nearly as long as the shell; beak inconspicuous, not projecting beyond the hinge line and situated near the middle of it; surface marked by faint concentric undulations.

Length, 25 mm.; height, 23 mm.

Only one valve of this shell has been collected, and it does not show the characteristic muscular scars of Anomia, though from its form there is little doubt that it belongs to that genus.

Locality and position.—Two miles north of Lowerys, Tehama County, Cal., from the upper layers of the Knoxville beds, where it is associated with *Aucella crassicollis*, *Lytoceras batesi*, etc. The specimen was inside of a fragment of the last-named species.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23023.)

SPONDYLIDÆ.

Genus SPONDYLUS Linnæus.

SPONDYLUS FRAGILIS n. sp.

Pl. II, fig. 3.

Shell of small or medium size, almost equilateral, irregularly ovate in outline; left valve convex, with rounded, not very prominent beak and rather large, well-defined, subequal ears; surface marked by numerous small, irregularly undulating, radiating lines that show a tendency to become subspinous on well-preserved examples. Right valve unknown.

The small specimen figured is 18 mm. long and 17 mm. wide. Fragmentary specimens in the collection represent individuals having fully twice these dimensions, and some of them show the characteristic hinge structure of Spondylus.

Locality and position.—The 12 specimens studied all came from the fossiliferous shales in the upper part of the Knoxville beds, near Stephenson's, on Cold fork of Cottonwood Creek, Tehama County, Cal.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23024.)

LIMIDÆ.

Genus LIMA Bruguèire.

LIMA MULTILINEATA n. sp.

Pl. II, figs. 4 and 5.

Cf. *Lima microtis* Gabb, 1864, Palæont. Cal., Vol. I, p. 202, pl. 26, fig. 189.

Shell large, very obliquely elongate oval, moderately convex; hinge line short; posterior ear well developed, triangular; anterior ear small and almost concealed by the inflection of the anterior side of the shell; posterior margin and base forming a regular curve from the posterior ear to near the anterior end of the shell; anterior margin abruptly inflected, so that it is nearly straight or slightly concave from the beak for three-fourths the length of the shell, and thence regularly rounded into the base; surface marked by very numerous (about 75) slender, somewhat flattened, simple, radiating ribs, which are usually slightly broader than the interspaces, excepting toward the free margins of large shells, where they become more widely separated. The irregularly undulating character of the ribs is well shown in the drawing.

Length of the largest type, 68 mm.; height, about 50 mm.

Lima microtis Gabb, from the "Chico group of Cottonwood Creek," is closely related to this species in form and general character of ornamentation. It seems, however, to be somewhat less oblique, and the interspaces between the ribs are "serrated on the sides and marked in the middle by a series of small pits or punctations," while in *L. multilineata* the interspaces are nearly or quite smooth. I have not been able to make direct comparisons with Gabb's type, but I have examined it since this collection has been in my hands, and I believe it to be distinct.

Locality and position.—Near Stephenson's, on Cold fork of Cottonwood Creek, Tehama County, Cal., with the preceding species.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23025.)

PECTINIDÆ.

Genus PECTEN Müller.

PECTEN CALIFORNICUS Gabb ?

Pl. II, fig. 10.

Pecten californicus, Gabb, 1864, Palæont. Cal., Vol. I, p. 201, pl. 31, fig. 270.

Shell small, subovate, slightly convex; anterior ear of right valve much produced, rather slender, with a deep byssal notch below it; posterior ear small, not very distinctly marked; beak small and pointed; surface smooth or with faint lines of growth, excepting on the anterior ear, where there are several radiating lines.

Length, 8 mm.; height, 9 mm.; length of hinge line, 5 mm.

The above description is drawn from a single right valve, which agrees too closely with the description and figure of *P. californica* to warrant its separation.

Locality and position.—The specimen here described was collected in the upper part of the Knoxville beds, near Stephenson's, on Cold fork of Cottonwood Creek, Tehama County, Cal. The type of the species came from the "Chico or Shasta group, Cottonwood Creek, Shasta County."

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23026.)

PECTEN sp.

Pl. II, fig. 6.

Shell rather small, subcircular in outline, depressed; surface apparently smooth; full form of the ears unknown.

Length, 21 mm.; height from beak to base, 18 mm.

A single cast of a left valve that probably belongs to an undescribed species, but not sufficient to furnish the basis for a specific name and description. It is apparently related to *P. operculiformis* Gabb and *Amusium lenticulare* Whiteaves, from both of which it differs in having a more nearly circular form and much greater length in proportion to its height.

Locality and position.—On the south fork of Elder Creek, Tehama County, Cal., about 3,000 feet below the top of the Knoxville beds, where it is associated with *Aucella piochii*.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23027.)

PECTEN COMPLEXICOSTA Gabb.

Pl. II, figs. 7–9.

Pecten complexicosta Gabb, 1869, Palæont. Cal., Vol. II, p. 199, pl. 33, figs. 97, 97*a*.

Original description.—"Shell moderate in size, thin, equivalve, nearly equilateral; sides and base forming a regular curve, slightly elongated; the right side of the upper valve, and corresponding side of the lower, a little the most convex above; upper valve with the left ear a little concave on its lateral margin; shape of the right ear unknown; right ear of lower valve narrow, produced, and deeply emarginate; surface marked by about 12 or 14 radiating ribs, with sometimes an equal number of smaller ones intercalated; these are more strongly marked on the cast than externally; besides the ribs, the entire surface is closely sculptured by minute radiating lines, very variable in size."

This description was based on fragmentary specimens from "white limestone of the Shasta group, in Morgan Valley, south of Clear Lake," Lake County, Cal., and Gabb's figure is a restoration from these specimens.

The species is abundant, associated with *Rhynchonella whitneyi* and *Modiola major*, in the white limestone at Wilbur Springs, on Sulphur

Creek, Colusa County, Cal. The ears are large and triangular, and the byssal notch of the right valve is broad and comparatively shallow. The left valve is perceptibly more convex than the right. None of the specimens from this locality shows the minute radiating lines mentioned in the description; nor are they shown in the original restored figure, excepting in a magnified view of a portion of the surface. Fragmentary specimens recently collected by Mr. Jasper Palmer, jr., of Reiff, Cal., at or very near the original locality, have this fine radiating sculpture well developed. Possibly the specimens from Wilbur Springs should be separated as a variety, but they agree so closely in all other respects that it seems probable that the absence of the fine lines is due to the state of preservation. They are all more or less in the form of internal casts, none preserving the outer surface of the shell. An average specimen measures 50 mm. in height, 44 mm. in greatest length, 17 mm. on the hinge line, and 14 mm. in convexity of both valves united.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23028 and 23102.)

AVICULIDÆ.

Genus AVICULA Bruguière.

AVICULA (OXYTOMA) WHITEAVESI n. sp.

Pl. IV, fig. 1.

Cf. *Oxytoma mucronata* (M. and H.) Whiteaves, 1884, Mesozoic Fossils, Vol. I, pp. 238, 251; pl. 31, fig. 9; pl. 33, figs. 6, 6*b*.

Sheil rather small, obliquely ovate; left valve convex, with greatest convexity a short distance below the beak; anterior wing small, triangular; posterior wing elongated and narrow; hinge line nearly or quite equal to the greatest length of the shell; beak prominent, projecting beyond the hinge line; anterior and basal margins forming a regular curve; posterior margin more sharply rounded; surface ornamented by about 18 rounded linear costæ, 2 or 3 of which are on the posterior wing. Some of the interspaces bear a single finer line, which does not extend to the umbo.

Greatest length, 18 mm.; height, 16 mm.; convexity of left valve, nearly 5 mm.

This description is drawn from a single specimen found with *Aucella crassicollis*, etc., in the upper part of the Knoxville beds on Shelton's ranch, 5 miles north of Paskenta, Cal. Another left valve referred to the same species, differing from the type in being slightly higher in proportion to its length, comes from the lower part of the Horsetown beds at Ono, Shasta County. Associated with the Ono specimen there are a number of right valves that probably belong to this species.

They have about the same outline, but are much less convex; the posterior wing seems to be more narrow, and the radiating lines are so small as to be inconspicuous except under a lens.

I think it probable that these fossils are identical with the form above mentioned from the Queen Charlotte Islands that has been referred to the Jurassic *Avicula* (*Oxytoma*) *mucronata* M. and H. Direct comparison of the California specimens with Meek and Hayden's original type, which was described and figured[1] under the name *Pteria munsteri* (Bronn), shows recognizable differences in both outline and sculpture. When this Jurassic form was described the name *Pteria mucronata* was suggested for it in case it should prove to be distinct, but before this work appeared Gabb had used *Avicula mucronata* for a California Triassic species;[2] consequently the name *mucronata* can not be applied to either of those species, and I name the Cretaceous form in honor of Mr. Whiteaves. A new name will also be given to the Jurassic species in another publication.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23029.)

Genus AUCELLA Keyserling.

Some of the specimens of *Aucella crassicollis* are in an excellent state of preservation and show well the hinge structure and other generic characters (Pl. V, figs. 1–3 and 7). The hinge plate is rather narrow, long, and toothless, but at its anterior end in the right valve there is a projecting tooth-like angle on the margin of the shell that fits into a corresponding notch under the beak of the left valve.

The ligament, which is usually described as external, was situated in a long, shallow, oblique groove, and must have been almost concealed by the overhanging edges of the valves. The most distinctive feature of the genus is the deep byssal notch and groove in the right valve, which is formed by the abrupt inflection of the shell, and is seen on internal casts almost as distinctly as on the shell itself. This narrow groove extends in a curve from the margin of the shell almost to the point of the beak, showing that it is developed at an early stage in the shell's growth. The small triangular area thus separated from the body of the shell may be regarded as the anterior ear or wing. At its anterior angle it bears the tooth-like projection above mentioned, and its free margins are both concave, the upper one fitting against the incurved beak of the left valve and the lower receiving a rounded projection on the margin of the same valve. This projecting portion of the margin, which probably represents a deflected ear, is bounded by an ill-defined groove corresponding in position to the byssal sinus of the other valve. The interlocking of these portions of the anterior margins of the two valves would seem to have served all the purposes of hinge teeth.

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[1] Palæontology Upper Missouri, p. 80, Figs. A and B, in text.

[2] Palæont. Cal., Vol. I, p. 30; pl. 5, fig. 27.

Most authors have placed Aucella in the same subfamily with Inoceramus, though the two genera have little in common except in some cases a similarity of outline and sculpture. The presence of the byssal sinus and the simple form of the ligamental groove as compared with the row of pits for the ligament in Inoceramus show that they are not very closely related. The genus Pseudomonotis (=Eumicrotis Meek) is a near relative of Aucella, as Meek[1] long since pointed out, and no one would think of associating it very closely with Inoceramus.

STRATIGRAPHIC AND GEOGRAPHIC RANGE OF AUCELLA.

Lahusen's excellent monograph, "Ueber die Russischen Aucellen,"[2] shows that in Russia the genus begins with *A. radiata* in the lower part of the Upper Jura (Oxfordian), associated with *Cardioceras cordatum*, but first becomes abundant in the overlying beds with *Cardioceras alternans*. Thence it continues abundant, with gradually changing forms, up into the Lower Cretaceous. The earliest species (*radiata bronni*, and *pallasi*) are elongate, compressed forms, with relatively long hinge lines, distinct posterior wings on both valves, and generally with radiating striæ. These are succeeded by a series of changing forms, until in the Lower Cretaceous the genus is represented by more robust, ventricose, and almost equivalve species without distinct posterior wings or radiating striæ. The oldest American forms of Aucellæ now known, those of the Mariposa slates, closely resemble the Russian species from the zone of *Cardioceras alternans*, and it has been recently shown by Profs. J. P. Smith[3] and A. Hyatt[4] that they are associated with a similar cephalopod fauna.

In the Knoxville beds, which seem to represent all of the Neocomian, occurs the series of forms described beyond, in which nearly all the later Russian Aucellæ are duplicated, or are represented by similar forms, and the different types are introduced in the same relative order in both countries. It is therefore possible to determine to some extent the relative stratigraphic position of different portions of the Aucella-bearing series in any region by means of the forms of Aucella that they contain, but this does not necessarily imply that the identical or similar forms were strictly contemporaneous in such distant regions as Russia and California.

There seems to be no clear evidence of any earlier species of Aucella than *A. radiata*. Professor Hyatt cites[5] *Aucella leguminosa* Stoliczka as coming from the "Tagling limestone, Lower Lias of India," in support of his view that the genus originated in the south and migrated northward, but this species really comes from the Spiti shales overlying the Tagling limestone, though it is figured on the same plate with

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[1] Paleontology of the Upper Missouri, p. 53. Washington, 1864.
[2] Mém. du Comité géologique, Vol. VIII, No. 1, St. Petersburg, 1888.
[3] Bull. Geol. Soc. Am., Vol. V, pp. 250–258.
[4] Ibid., pp. 402–438.
[5] Bull. Geol. Soc. Am., Vol. V, 1894, p. 407.

species from the latter horizon. Stoliczka referred the Spiti shales to the Oolite, and placed the overlying Giumal sandstone in the Upper Jura. The last-named formation has since been classed as Neocomian,[1] and it is quite probable that the Spiti shales also, which have yielded very few fossils, are younger than Stoliczka supposed. Another species, *Aucella parva* Stoliczka, has been described as from the Upper Cretaceous (Cenomanian) of India. This small form has been inadequately illustrated and needs further study. In Russia the latest Aucella beds are referred to the Neocomian, which may be taken as the general upper limit of the range of Aucella. Whiteaves has correlated the Aucella beds of British Columbia with the Gault, but judging from the stratigraphic relations of similar faunas in California and Oregon, this correlation was caused by the failure of the geologists to differentiate the horizons in the field, and fossils that really overlie the Aucellæ are treated as part of the same fauna.

In its geographic distribution Aucella is essentially circumpolar, though in some regions it extends far southward. It is found over a large part of Russia, in Siberia, Nova Zembla, Spitzbergen, on the Island of Andoe on the coast of Norway, Kuhn Island on the east coast of Greenland, in Alaska, British Columbia, including Queen Charlotte and Vancouver islands, and the west coast of the United States as far south as San Luis Obispo County, Cal. (about latitude 35°). In Mexico it is reported from Catorce, San Luis Potosi, which is only a few miles north of the tropic, in longitude 101° west. Its occurrence in India (northern Himalayas) has already been mentioned. In all these regions it is abundant, filling the beds where it occurs, and in most of them the early types, resembling *A. radiata* and *A. bronni*, as well as the later ones, are found. Wherever the original center of distribution may have been, therefore, it seems quite certain that the genus must have been widely distributed in the Arctic and Pacific oceans considerably before the close of the Jurassic and before there was much specific differentiation. To my mind it is not unreasonable to suppose that this original stock, after being so widely distributed, may have developed in the same general direction and produced closely similar series of forms independently in different regions.

Outside of these regions of its abundant occurrence Aucella has been occasionally reported, as in England[2] and Austria-Hungary.[3] Two species have been described from the southern hemisphere, *Aucella plicata* Zittel,[4] from New Zealand, and *Aucella braziliensis* White,[5] but in neither of these cases is the generic determination entirely certain.

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[1] R. D. Oldham, Geology of India, p. 229, 2d ed., 1893.

[2] Pavlow, Jurassique supérieur et crétacé inférieur de la Russie et de l'Angleterre, Bull. Soc. Nat. de Moscou, 1889, No. 1, p. 126, pl. 3, figs. 4, 5.

[3] Neumayr, Die Fauna der Schichten mit Aspidoceras acanthicum, k. k. Geol. Reichsanstalt, Bd. V. p. 206, Wien, 1873.

[4] Reise der österreichischen Fregatte Novarra, Geol. Theil., Vol. I, pt. 2, Palæont., p. 32, pl. 8, figs. 4*a*, 4*b*, 4*c*.

[5] Contributions to the Paleontology of Brazil, p. 56, pl. 3, figs. 11-13, in Archivos do Museu Nacional do Rio de Janeiro, Vol. VII.

AUCELLA PIOCHII Gabb.

Pl. IV, figs. 2–14.

Inoceramus piochii Gabb, 1864 (in part), Palæont. California, Vol. I, p. 187, pl. 25, fig. 173, *not* fig. 174.

Aucella piochii Gabb, 1869 (in part), Palæont. California, Vol. II, p. 194, *not* the figures on pl. 32.

? Aucella piochii (Gabb) Whiteaves, 1882 (in part as synonym of *A. mosquensis*), Trans. Roy. Soc. Canada, Vol. I, sec. 4, p. 84.

Aucella mosquensis [von Buch] White, 1885, Bull. U. S. Geol. Surv., No. 15, p. 23.

? Aucella piochii (Gabb) Whiteaves, 1887 (in part), Rept. Geol. and Nat. Hist. Surv. Canada, n. s. Vol. II, p. 111b.

? Aucella mosquensis var. *concentrica* Whiteaves, 1889 (in part), Cont. to Can. Palæont., Vol. I, p. 151.

Aucella concentrica [Fischer] White, 1889 (in part), Mon. U. S. Geol. Surv., No. XIII, p. 231, pl. 4, figs. 1, 18–20.

Aucella piochii (Gabb) Stanton, 1894, Bull. Geol. Soc. Am., Vol. V, p. 447.

Cf. *Aucella pallasi* (Keyserling) Castillo and Aguilera, 1895, Boletin de la Comision Geológico de Mexico, No. 1: Fauna fosil de la Sierra de Catorce, p. 4, pl. 2, figs. 14, 15; pl. 3, figs. 1, 2, and 6.

Cf. *Aucella fischeriana* (d'Orbigny) C. and A., idem., pl. 3, figs. 3–5, 7–12.

The original description, omitting the references to the "left" valve, which Mr. Gabb afterwards recognized as belonging to an entirely different form—*Mytilus quadratus*—and changing "right" valve to left valve, is as follows:

"Shell small, thin, inequivalve, high, and narrow. Left valve with the beaks large, prominent, incurved, and placed directly along the anterior margin; posterior margin to the most prominent part of the base forms a pretty regular elliptic curve; anterior margin sinuated. * * * Surface marked by small concentric ribs, which sometimes take the form of moderately large undulations."

In the second volume of Palæontology of California the description was enlarged and modified so as to make the species include the robust, inflated forms (*A. crassicollis*) of the upper part of the Knoxville, and the typical form first described was treated as the young stage of growth. Since that time it has been customary to regard all the Cretaceous Aucellæ of the Pacific Coast as only varieties of one species, though sometimes they have been ranged under two names for convenience. Recent field work,[1] however, has shown that some of these forms are characteristic of particular zones in the Lower Cretaceous, and are therefore of sufficient stratigraphic importance to be treated as distinct species, even though they may be closely connected in a genetic series.

The typical variety of *A. piochii* (Pl. IV, figs. 2–4, 8, 10) may be distinguished from all the other Knoxville forms by its slender, obliquely ovate form, with very prominent, narrow umbonal region and strongly

[1] Hyatt, Trias and Jura in the Western States, Bull. Geol. Soc. Am., Vol. V, p. 404. Diller and Stanton, The Shasta-Chico Series, idem, p. 447.

incurved beak in the left valve; by the presence of small, but well-defined posterior wings or ears on both valves, making the hinge line straight; and by somewhat regular, small, concentric undulations. The right valve is much less convex, with a more elliptical outline, the beak scarcely projecting beyond the hinge. The anterior ear of this valve is very small and is separated from the body of the shell by the narrow byssal sinus.

Occasional specimens are found showing faint radiating striæ (fig. 9), and such examples very closely resemble *Aucella erringtoni* var. *arcuata* Hyatt from the Jurassic Mariposa slates, which has almost the same form. The resemblance is so close that they probably would not be separated if they were found together or with the same faunal associates. As Professor Hyatt has pointed out, the facts at present known seem to indicate that *A. piochii* is the direct descendant of *A. erringtoni*.

Of the Russian forms figured by Lahusen, *Aucella mosquensis*, *A. fischeriana*, and *A. trigonoides* may be compared with *A. piochii*, but none of the specimens or figures of these species I have seen shows such a prominent incurved beak nor so narrow an umbonal region suddenly expanding into the body of the shell below as in the left valve of *A. piochii*.

Variety ovata[1] (Pl. IV, figs. 11–14).—This variety, which occurs with the preceding, though it ranges a little higher in the Knoxville beds, may be distinguished from it by its larger size, more broadly triangular form, greater convexity, and coarser, more remote concentric undulations. The posterior ear is scarcely at all developed in either valve, and the beak of the right valve is much more prominent and pointed, so that the hinge line is short and angular.

This form resembles the Russian *A. mosquensis* var. *ovata* and *A. trigonoides*, which, according to Lahusen, seem to be connected with each other and with *A. keyserlingi* by transition forms. In the upper part of the Knoxville beds there are occasional specimens that I at first referred to this variety (Bull. Geol. Soc. Am., Vol. V, p. 448), but which now seem to me rather a variety of *A. crassicollis*, and they are very much like the figures of *A. keyserlingi* (see Pl. V, figs. 12, 13).

The small specimen represented by Pl. IV, figs. 6 and 7, is intermediate between the typical *A. piochii* and var. *ovata*, as it has the slender form of the one and the sculpture, convexity, and pointed right valve of the other. The very large specimen (Pl. IV, fig. 14) is another extreme variation, approaching *A. crassicollis* var. *gracilis* in outline and size, but the character of the umbonal region shows its relationship to *A. piochii* var. *ovata*.

In size *A. piochii* is usually small, the greatest length, measured obliquely from the beak, seldom exceeding 30 or 35 mm., and the greatest breadth at right angles to that line is about 20 mm.

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[1] Bull. Geol. Soc. Am., Vol. V, p. 447.

One distinctive character, as compared with *A. crassicollis*, is the extreme thinness of the shell, even in the larger varieties.

Locality and position.—The typical form occurs alone in the lowest known fossiliferous beds of the Knoxville. It ranges through several thousand feet of strata, and in the upper part of its range is associated with the variety *ovata*. The latter is the predominant form at a horizon about 2,000 feet below the top of the Knoxville, and above this horizon of its culmination it is gradually replaced by *Aucella crassicollis*. The original figures on Pl. IV are all from specimens collected on the south fork of Elder Creek, Tehama County, Cal., and between that and the north fork of the same creek, excepting fig. 4, which was collected $2\frac{3}{4}$ miles northwest of Paskenta. The striated specimen (fig. 9) is from the neighborhood of Knoxville, Napa County, Cal.

The species is also known from the Santa Lucia Range, in San Luis Obispo County, 5 miles west of Santa Margarita, where it has been collected by Mr. Turner[1] and by Mr. Fairbanks;[2] from the mouth of Alum Rock Canyon, 7 miles east of San Jose, where it was obtained by Prof. J. P. Smith,[3] who mentioned it as Aucella of the type of *A. mosquensis;* from the north side of Mount Diablo, the neighborhood of Berkeley, and many places farther north in the coast ranges of California; from the neighborhood of Riddles, Oreg., and near Seattle, Wash.

Judging from the published figures, it is probable that some of the Aucellæ collected near Catorce, in San Luis Potosi, Mexico, belong to this species, and especally to the variety *ovata*, though they have all been referred to Russian species.

The Aucellæ collected by Dr. George M. Dawson on the Skagit River, British Columbia, in 1875, seem to belong to *Aucella piochii* var. *ovata*. Those from other British American localities that I have been enabled to examine, through the kindness of Mr. J. F. Whiteaves, are all *Aucella crassicollis*, under which name the localities will be enumerated. Judging from the range of these forms in California, only the upper part of the Aucella-bearing beds have yet been found in British Columbia. The specimen from Queen Charlotte Islands, referred to *Aucella mosquensis* and figured in Mesozoic Fossils, Vol. I, pl. 10, figs. 3, 3*a*, is most probably not an Aucella; indeed, it seems to me more nearly related to the Astartidæ.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23030–23033.)

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[1] Mon. XIII, U. S. Geol. Surv., p. 381.

[2] Twelfth Rept. State Mineralogist of California, p. 512, San Francisco, 1894.

[3] Bull. Geol. Soc. Am., Vol. V, p. 257.

AUCELLA CRASSICOLLIS Keyserling.

Pl. V, figs. 1–13; Pl. VI, figs. 1–5.

Aucella crassicollis Keyserling, 1846, Reise in das Petschora-Land, p. 300, pl. 16, figs. 9–12.

Aucella piochii Gabb, 1869 (in part), Palæont. California, Vol. II, p. 194, pl. 32, figs. 92*a*–92*c*.

Aucella piochii (Gabb) Whiteaves, 1882 (in part), Trans. Roy. Soc. Canada, Vol. I, sec. 4, p. 84; 1884, Mesozoic Fossils, Vol. I, p. 239; 1887 (in part), Geol. and Nat. Hist. Surv. Canada, Vol. II, n. s., p. 111*b*.

Aucella concentrica (Keyserling) Toula, 1874, Zweite deutsche Nordpolarfahrt, Vol. II, p. 503, pl. 2, figs. 2–4.

Aucella concentrica (Fischer) White, 1884, Bull. U. S. Geol. Surv. No. 4, p. 13, pl. 6, figs. 2–12; 1885, Bull. U. S. Geol. Surv. No. 15, p. 23; 1889 (in part), Mon. U. S. Geol. Surv. No. XIII, p. 231, pl. 4, figs. 3–5, 11–17, and 21.

Aucella crassicollis and var. *gracilis* Lahusen, 1888, Ueber Russischen Aucellen, pp. 24, 42, pl. 5, figs. 8–16, where European synonomy is given.

Aucella piriformis Lahusen, 1888, ibid., pp. 22, 42, pl. 5, figs. 1–7.

Cf. *Aucella terebratuloides*, *inflata*, and *keyserlingi* Lahusen, ibid., pp. 18–22, 39–41, pl. 4, figs. 1–21.

Cf. *Aucella bulloides* Lahusen, ibid., pp. 25, 43, pl. 5, figs. 17–19.

Aucella crassicollis (Keyserling) Stanton, 1894, Bull. Geol. Soc. Am., Vol. V, p. 448.

Cf. *Aucella terebratuloides* (Trautschold) Castillo and Aguilera, 1895, Boletin de la Comision Geológico de Mexico, No. 1, Fauna fossil de la Sierra de Catorce, p. 4, pl. 3, fig. 13.

Cf. *Aucella volgensis* (Lahusen) C, and A., idem., pl. 3, figs. 14–16.

Shell attaining a large size, ovate in outline, but varying greatly in the relation of length to breadth, ventricose, with the two valves almost equally convex; beaks approximate, in left valve prominent and more or less strongly incurved, in right valve pointed and deflected forward; surface variable, some specimens being almost smooth, with irregular concentric furrows and constrictions, while others are marked by strong concentric plications both on the surface of the shell and on the casts; posterior wing not developed on either valve; byssal groove and notch deep and conspicuous. The right valve is always shorter and more triangular than the left.

This description is meant to include all the robust varieties of Aucella that are characteristic of the upper part of the Knoxville beds in California, ranging through perhaps 1,500 or 2,000 feet of strata. The figures given illustrate the principal variations in form, but the individual variation is so great that one seldom finds two specimens exactly alike.

A precisely similar series of forms has been described from the Lower Cretaceous of Russia and beautifully illustrated by Lahusen. The name *A. crassicollis* was originally given to an elongate form (*A. crassicollis* var. *gracilis* Lahusen) with irregular concentric constrictions, much like the one represented by figs. 10 and 11 on Pl. V. The type differs from the California specimen principally in having the beaks more distinctly coiled and incurved, but this distinction will not hold,

for we have other California specimens from the same bed and locality that show this feature, and there are others that show the intermediate amounts of incurving.

Lahusen has recognized the shorter, more ventricose, forms, like our figures 3, 4, and 9 of Pl. V, as varieties of *crassicollis*, but other specimens that seem to differ only in having the beak of the left valve less distinctly spiral are separated under the name *A. piriformis*, which he says "is closely connected with *A. crassicollis* by gradual transitions" and is everywhere associated with it. These facts seem to me sufficient reason for assigning all these forms to the same species.

The name *Aucella concentrica* Fischer de Waldheim, which has been used by many authors for this species, was justly rejected by Lahusen. The only reason it has ever been used is because Fischer de Waldheim[1] published three figures of Aucella under the name "*Inoceramus concentricus* Brongniart," and when his fossils were found to belong to a new genus as well as a new species the specific name by which he had known them was retained and credited to him. Lahusen's name, *piriformis*, was proposed for precisely the same forms with citations of Fischer's figures, but if it is really conspecific with *A. crassicollis* Keyserling, as I believe, Keyserling's name must be used under the rule of priority.

The large forms thus far referred to are especially characteristic of the uppermost Knoxville beds, and I think that no one who has handled large collections of them would hesitate to refer them to one species. Some of the others may perhaps be considered rather more doubtful, but I have failed to find any constant feature or any combination of characters by which they may be separated. Figs. 8, 12, and 13 of Pl. V, also from the Upper Knoxville, approach *A. piochii* var. *ovata* in form, but they are less oblique, and differ in surface sculpture, and there is evidence from connecting forms that they belong with *A. crassicollis*. Figs. 12 and 13 are also much like Lahusen's figures of *A. keyserlingi*.

Figs. 3, 4, and 5 on Pl. VI represent a strongly plicate variety that also ranges to the top of the Knoxville beds, though the specimens illustrated were obtained 1,500 or 2,000 feet lower, north of Paskenta and one-fourth mile east of Henderson's. Judging from Lahusen's figures, they may be considered intermediate between *A. inflata* and *A. terebratuloides*. At many localities the specimens all have these strong concentric ridges, but the sculpture is not sufficiently constant for use as a specific distinction.

The small specimen represented by figs. 5 and 6 on Pl. V is from a still lower horizon, associated with great numbers of *A. piochii* var. *ovata* and *Belemnites tehamaensis*. It differs from the common form of *A. crassicollis* in its smaller size, somewhat longer hinge line, and broader beak of the right valve.

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[1] Oryctographie de Moscou, pl. 20, figs. 1-3, St. Petersburg, 1830.

A. crassicollis is by far the most abundant species of Aucella in the collections that have been brought in from California. It occurs at many localities in the coast ranges, from San Luis Obispo County, where it was recently collected by Mr. Fairbanks, northward to the Cold fork of Cottonwood Creek, though I do not know any localities at which it has been obtained between San Luis Obispo County and Napa and Lake counties. It occurs also at Riddles, and at other localities in Oregon and Washington.

The Aucellæ from the following localities in British Columbia belong to this species, viz: Queen Charlotte Islands, south shore, opposite Cowgatz; Forward Inlet, Quatsino Sound, Vancouver Island; Tatlayoco Lake, latitude 51° 30′, longitude 124° 30′, and Harrison Lake. It also occurs on Kuhn Island, east coast of Greenland; at Port Möller, Peninsula of Alaska, and at many localities in northern Russia.

The original figures on Pl. V and figs. 3–5 of Pl. VI are all from specimens collected between Elder Creek and Paskenta, Tehama County, Cal., excepting Pl. V, figs. 1 and 2, which is from near Stephenson's, on the Cold fork of Cottonwood Creek, Tehama County.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23034–23039.)

Genus INOCERAMUS Sowerby.

INOCERAMUS OVATUS n. sp.

Pl. IV, fig. 15.

Shell of medium size, elongate ovate in outline, subequivalve, moderately convex; beaks prominent, narrow, pointed, curved slightly forward, and situated near the anterior end of the very short hinge line, which is oblique to the longer axis; surface of the shell and of the cast marked by distant, obscure, irregular, concentric undulations parallel with the lines of growth.

Length of shell equal to about two-thirds of height.

This form resembles some of the varieties of *I. fragilis* H. and M., from which it may be distinguished by the shorter hinge line, fuller anterior margin, and less oblique form. None of the described species from the Pacific Coast resembles this one closely enough to require detailed comparison.

Locality and position.—On the south fork of Elder Creek, Tehama County, Cal., about 2,000 feet below the top of the Knoxville beds, where a single specimen was found associated with *Aucella piochii* var. *ovata* and *Belemnites tehamaensis*.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23040.)

MYTILIDÆ.

Genus MODIOLA Lamarck.

MODIOLA MAJOR Gabb.

Pl. III, fig. 1.

Modiola major Gabb, 1869, Palæont. California, Vol. II, p. 191, pl. 31, fig. 88.

Original description.—"Shell very large, thick, slightly curved; beaks small, about an eighth of the length from the anterior end, which is narrowly rounded and produced; cardinal margin slightly arched; base concave in the middle, convex posteriorly; posterior end irregularly convex, most prominent below; surface marked by coarse, irregular lines of growth.

"Length, 4.8 inches; width, 2.4 inches; diameter, about 1.5 inches.

"Common in the white limestone of the Shasta group, east of Knoxville, Lake County; also found smaller in the same beds in Morgan Valley, south of Clear Lake, Colusa County.

"A fine species, well characterized by its size, being the largest species of the genus with which I am acquainted. Some specimens are over 6 inches in length."

The specimen figured on Pl. III, which is the largest I have seen, is not quite so slender as Gabb's original figure, but the smaller specimens associated with it in the same bed are also more slender. It was obtained from a limestone in the lower part of the Horsetown beds, about 1 mile east of Stephenson's, on Cold fork of Cottonwood Creek, Tehama County, Cal. Mr. James Storrs has recently collected the species from about the same horizon on the north fork of Cottonwood, near the mouth of Eagle Creek, Shasta County. The localities mentioned by Gabb are probably all in the Knoxville beds. I found it quite abundant, associated with *Pecten complexicosta*, *Rhynchonella whitneyi*, etc., in the white limestone near Wilbur Springs, Colusa County, which is certainly in the Knoxville. This is therefore one of the species that are common to the Knoxville and Horsetown beds.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23041.)

Genus MYOCONCHA Sowerby.

MYOCONCHA AMERICANA n. sp.

Pl. II, fig. 11.

Shell rather small, slender, subovate, gently convex; beak small, almost terminal; dorsal margin nearly straight, passing by a gentle curve into the rounded posterior end; ventral margin also nearly straight, slightly contracted toward the front, and gently convex

behind; shell gradually broadening from the narrow anterior end for about two-thirds of its length, and thence rounded to the posterior end; surface marked by lines of growth.

Length, 41 mm.; greatest width, 22 mm.

The genus Myoconcha has not before been recognized in American strata, and the present species is represented by only a single right valve, but the general form and the presence of a single tooth and a long groove for the external ligament make its generic reference reasonably certain.

Locality and position.—Near Stephenson's, on Cold fork of Cottonwood Creek, Tehama County, Cal., in the upper part of the Knoxville beds.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23042.)

PINNIDÆ.

Genus PINNA Linnæus.

PINNA sp.

Pl. II, fig. 12.

A single very small valve of a young Pinna was found in the upper part of the Knoxville beds, on Shelton's ranch, 5 miles north of Paskenta, Cal. As it is probable that an adult shell would not be recognizable from the figure and description of this specimen, I have not ventured to give it a name.

The right valve is elongate subtriangular in outline, increasing rapidly in breadth from the very narrow pointed front end, carinated, the carina beginning at a point about 1 millimeter behind the beak and curving slightly downward, so that the dorsal area is somewhat broader than the ventral; posterior end of the dorsal area squarely truncate, while the corresponding margin of the ventral area is directed very obliquely forward with a slightly sinuous outline; surface marked by very distinct, sharply elevated lines parallel to the posterior margin and averaging one-half millimeter apart, crossed by much finer, closely arranged radiating lines and the narrow median carina. There is also another faintly marked ridge passing down the middle of the dorsal area.

Length of the young individual, 9 mm.; greatest breadth, 6 mm.

The extreme apex of the shell—about one-fourth of a millimeter—is slightly eroded, but the radiating lines extend as far as the original surface remains, and the beak seems to have been strictly terminal.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23043.)

ARCIDÆ.

Genus ARCA Linnæus.

ARCA TEHAMAENSIS n. sp.

Pl. VI, fig. 8.

Shell small, elongate subtrapezoidal in outline; hinge line as long as the shell, with a low area; beak elevated, prominent, situated about one-third the length of the shell from the anterior end, which is rounded and slightly narrower than the posterior end; base nearly straight and almost parallel with the cardinal margin; posterior end truncate, forming an angle of about 100° with the cardinal margin; posterior umbonal ridge prominent, subangular, and the portion of the shell above it much depressed; surface marked by distinct, somewhat regular lines of growth and by much finer, more closely arranged radiating lines, which are visible only under a lens and are most prominent on the posterior portion of the shell.

Length, 7 mm.; height, 4 mm.

The specimen above described is a natural mold of a right valve, probably an immature individual. It may be identical with the undescribed Arca from the Lower Cretaceous of Jackass Mountain, British Columbia, mentioned by Whiteaves (Trans. Roy. Soc. Canada, Vol. I, Sec. IV, p. 85) as similar to *Arca carteroni* d'Orbigny. *Nemodon fischeri* (d'Orbigny) Whiteaves, from the east end of Maud Island, seems to be a related form, and if our specimen is a very young shell it may prove to be identical, though there are differences in the outline, especially of the base, and in the form of the posterior end. I have not seen the hinge, but the general form of the shell makes it probable that it belongs to the subgenus Nemodon.

Locality and position.—Shelton's ranch, 5 miles north of Paskenta, Tehama County, Cal., in the upper part of the Knoxville beds, where it is associated in the same layers with *Aucella crassicollis*, *Hypsipleura gregaria*, etc.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23044.)

ARCA TEXTRINA n. sp.

Pl. VI, figs. 6 and 7.

Shell of medium size, elongate suboval in outline, moderately convex; hinge line considerably shorter than the greatest length of the shell, with a low area; base nearly parallel with the hinge, slightly sinuous in the middle and abruptly rounded into the oblique posterior end, which joins the dorsal margin in a gentle curve; beaks broad, not prominent; a broad, obscure depression extending from the beak to the middle of the base; surface marked by distinct, closely arranged lines of growth and by similar slightly larger radiating lines, which are not at all conspicuous to the unaided eye.

Length of the largest specimen seen, 38 mm.; height, 23 mm.; convexity of single valve, about 10 mm.

In size and general form this species may be compared with the *Grammatodon inornatus* Whiteaves, not M. and H. (Mesozoic Fossils, Vol. I, pl. 31, figs. 8*a*, 8*b*), from which it may be distinguished by its shorter hinge, more rounded ends, broader umbonal region, and the presence of radiating striæ.

Locality and position.—Near Stephenson's, on the Cold fork of Cottonwood Creek, Tehama County, Cal., in the upper part of the Knoxville beds.

Several small specimens collected at the locality on Shelton's ranch have the same form as this species, and probably are young individuals of it. One of these shows an impression of the hinge with elongate, nearly horizontal teeth at each end and short transverse ones in the middle, so that it should probably be referred to the subgenus Nemodon.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23045.)

Genus PECTUNCULUS Lamarck.

PECTUNCULUS ? OVATUS n. sp.

Pl. VI, figs. 9 and 10.

Shell small, subovate in outline, slightly oblique, convex; beaks rather narrow and prominent; front and base regularly rounded; posterior end subtruncate; surface marked by 8 or 10 prominent radiating costæ that are not quite as wide as the interspaces and are almost as prominent on internal casts as on the shell itself. These costæ on the anterior part of the shell are sharply angular, while all the others appear to be rounded, at least on the cast.

The hinge of this species, as determined from a cast of the right valve, consists of a curved series of about 12 or 14 transverse teeth, thus apparently agreeing with the genus Pectunculus, though its form and sculpture differ considerably from the common species of that genus.

Locality and position.—Near Stephenson's, on the Cold fork of Cottonwood Creek, Tehama County, Cal., in the upper part of the Knoxville beds.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23046.)

NUCULIDÆ.

Genus NUCULA Lamarck.

NUCULA GABBI n. sp.

Pl. VI, figs. 11 and 12.

Shell of medium size, subovate in outline, posterior end very short, obliquely truncate above, regularly rounded into the base below; dorsal margin in front of the beaks gently curved to the anterior end,

which is more narrowly rounded into the slightly convex base; beaks prominent, approximate and situated very near the posterior end of the shell; free margin smooth within; surface marked only by very fine but distinct lines of growth.

Length of the largest specimen seen, 20 mm.; height, 16 mm.; convexity of the two valves united, about 12 mm.

This species may be compared with *N. solitaria* Gabb (Palæont. Cal., Vol. II, p. 197, pl. 32, fig. 94), a Chico species from Texas Flat, Cal., which has, however, a more distinctly triangular outline than the form here described, besides being smaller and coming from a much higher horizon. Whiteaves's figures of *N. solitaria* from Queen Charlotte Islands are rather more like the present species, and as they also come from a lower horizon they may be identical with it.

Locality and position.—The type is from the upper part of the Knoxville beds, about 3 miles south of Lowerys, Tehama County, Cal. Several much smaller specimens were collected from a lower horizon in the small limestone 3 miles northwest of Paskenta.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23047.)

NUCULA STORRSI n. sp.

Pl. VI, figs. 13 and 14.

Shell of medium size, elongate subtriangular, convex; beaks large, prominent, approximate, situated a little less than one-third of the length of the shell from the anterior end; dorsal margin excavated behind the beak and gently sloping in front; posterior end narrowly rounded, subangular above; anterior end produced, narrowed and subangular at the extremity; ventral margin forming a broad curve or nearly straight; test moderately thick, with the inner free margin smooth; surface marked by very fine, closely arranged concentric lines that are barely visible without a lens.

Length of the figured specimen, 23 mm.; height, 13 mm.; convexity of both valves united, 10 mm. One other example is 26 mm. long, but all the rest of the nine specimens collected are considerably smaller than these two.

This species in general form resembles Leda rather more than the typical species of Nucula. It agrees with Nucula, however, in its thick shell, the apparent absence of a pallial sinus, and the fact that the beaks are turned toward the shorter end, which is therefore regarded as the posterior end. There is no closely related American Cretaceous species with which I am acquainted.

The specific name is given in honor of Mr. James Storrs, of Tehama, Cal., by whose skill and energy as a collector a large part of the species described in this paper was discovered.

Locality and position.—From the small limestone, 3 miles northwest of Paskenta, Cal., and about 3,000 feet below the top of the Knoxville beds.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23048.)

Genus LEDA Schumacher.

LEDA GLABRA n. sp.

Pl. VI, fig. 15.

Shell small, subequilateral, moderately convex; beaks small, situated very slightly in advance of the middle; cardinal border almost straight, being a little concave behind the beak and sloping very gently downward in front; anterior end narrowly rounded, but somewhat broader than the posterior end, which is subangular above; ventral margin broadly and regularly rounded; surface smooth or marked only by lines of growth.

The figured specimen, which is somewhat smaller than some of the other examples of the species, measures 9 mm. in length and 5 mm. in height.

This form has about the same outline as *Yoldia arata* Whiteaves (Mesozoic Fossils, Vol. I, p. 233, pl. 31, figs. 4 and 4*a*) from the Queen Charlotte Islands, but it is easily distinguished by its smoother surface. It is possible that the casts from the Aucella beds of Vancouver Island, doubtfully referred to *Y. arata* (Cont. to Canadian Palæont., Vol. I, p. 154), belong to the present species. As no other described species from the Cretaceous of the Pacific Coast is comparable with this one, I have thought it advisable to give it a provisional name, although it belongs to a persistent group that has very few salient features on which specific distinctions can be based.

Locality and position.—The type is from the fossiliferous shales in the upper part of the Knoxville beds near Stephenson's, on Cold fork of Cottonwood Creek, Tehama County. Other examples were collected from about the same horizon on Shelton's ranch, 5 miles north of Paskenta, Cal.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23049.)

CARDINIIDÆ.

Genus CARDINIOPSIS n. gen.

Shell in the type species large, elongate suboval, with the posterior end somewhat narrowed; ligament external, prominent, and long; hinge plate rather broad and flattened, bearing in the right valve a single moderately large triangular cardinal tooth, which is situated immediately below the beak, directed slightly forward and bordered on each side by a shallow pit; hinge of the left valve with two smaller diverging cardinal teeth inclosing between them a triangular pit for the reception of the tooth of the right valve; no lateral teeth; anterior adductor muscular impression large, subcircular, deeply impressed, with a well-marked, deep accessory muscle scar situated just above and behind it and impinging on the front part of the hinge plate; posterior adductor muscular scar very slightly impressed and so obscure that its

outlines are not distinguishable on any of the casts; pallial line well marked on the front half of the shell, but fading out so that it can not be traced posteriorly, but it is probably entire. (Elongate and thin-shelled species of Unio have similar faint muscular impressions on the posterior portion of the shell.) Type: *Cardiniopsis unioides* n. sp., described on a succeeding page.

The habitat of the type species was marine waters, where it was associated with Rhynchonella, Aucella, Lucina, Nucula, Solemya, Turbo, Amberleya, Ammonites, Belemnites, etc.

The external features of the large Unio-like shells, for which this new generic name is proposed, suggest at once a comparison with the Unionidæ and with the genera of similar aspect in the Paleozoic and earlier Mesozoic, such as Anthracosia, Carbonicola, Asthenodonta, Uniona, Cardinia, Trigonodus, etc.

In the Unionidæ the only genus with which comparison needs to be made is Unio itself, from which Cardiniopsis may be distinguished by the absence of lateral teeth[1] and by the character of the cardinal teeth, which are smooth, regular, and sharply defined in Cardiniopsis, while in Unio they are irregular in form, roughened, and striated; also by the difference in the number and position of the anterior accessory muscular impressions; and it differs from all known Unionidæ in its marine habitat. The genera mentioned above as associates of Cardiniopsis leave no doubt as to the marine character of the bed in which they are found, and the manner of their occurrence makes it certain that the specimens of Cardiniopsis were not drifted in from a river or other fresh waters, but that they actually lived with the species that are now found with them. They are relatively abundant in the small area of a few square yards where they have been found, and almost all the specimens have both valves united and nearly closed. Some of them are filled with Rhynchonella, Aucella, and other small forms, and none of them shows any evidence of erosion.

Uniona,[2] a marine genus from the Trias, has hinge structure and muscular impressions very much as in Unio, and hence differs in a similar manner from Cardiniopsis.

In some species of Trigonodus, from the Trias, and Cardinia, from the Jura (especially Lias), the cardinal teeth have somewhat greater resemblance to those of Cardiniopsis, but both these genera also have long, well-developed laterals.

The Paleozoic genera Anthracosia, Carbonicola, and Asthenodonta,[3] though having the same Unio-like form, differ too much from Cardiniopsis in their internal features to require detailed comparison.

In consideration of all the known characters of this fossil, its natural position seems to be near Cardinia and Trigonodus in the family Car-

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[1] These are also absent in some species of Unio that have been grouped under the name Margaritana, which, according to Mr. Charles T. Simpson, is not a valid genus.

[2] Pohlig, Maritime Unionen, Palæontographica, Bd. XXVII, pp. 109–127, pls. 13, 14, Cassell, 1880.

[3] J. F. Whiteaves, Unio-like Shells in the Coal Measures at the South Joggins, Nova Scotia, Trans. Roy. Soc. Canada, Sec. IV, 1893, pp. 21–24.

diniidæ, as defined in Zittel's Handbuch der Palæontologie and in Fischer's Manuel de Conchyliologie. A recent writer,[2] however, thinks that the family Cardiniidæ is not a valid one, and that Cardinia and Trigonodus should be placed in the "Nayades" or "Nayadidæ," which includes the Unionidæ. If this view be adopted Cardiniopsis will go into that group.

CARDINIOPSIS UNIOIDES n. sp.

Pl. VII, fig. 5; Pl. VIII, fig. 1; Pl. IX, fig. 1; Pl. X, fig. 1.

Shell large, elongate suboval, moderately convex; beaks not very prominent, approximate, and situated about one-third of the length of the shell from the front; cardinal margin descending rather rapidly, with convex outline in front of the beak and sloping more gently, with slightly concave outline behind; front end broadly rounded; posterior end narrower and more compressed, obliquely subtruncate above and rounded below; ventral margin forming a broad curve, most convex and prominent in the anterior third; surface marked by irregular and not very prominent lines of growth; test rather thick, especially in the ventral region. The characteristics of the hinge and other internal features are given above in the generic description.

One of the type specimens measures 175 mm. (nearly 7 inches) in length, 98 mm. in height, and about 55 mm. in greatest convexity of the two valves. The largest specimen collected is 8 inches long.

This is the largest species of the Pelecypoda known from the Knoxville beds, and, excepting the Inocerami, one of the largest from the American Cretaceous.

Two fragmentary specimens of another species of this genus were collected with *C. unioides*, but they are too imperfect for full description. In size and general appearance they resemble *Lucina colusaensis*, but impressions of the hinge show that it had the same structure as in *C. unioides*.

Locality and position.—In the small limestone, 3 miles northwest of Paskenta, Tehama County, Cal., and about 3,000 feet below the top of the Knoxville beds.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23050.)

SOLEMYIDÆ.

Genus SOLEMYA Lamarck.

SOLEMYA OCCIDENTALIS n. sp.

Pl. X, figs. 2 and 3.

Shell rather large, elongate oval, convex; beaks broad, but not prominent, and directed backward; posterior end very short and narrowly rounded; anterior end much produced and broader, but toward the

[2] S. Frh. von Wöhrmann, Ueber die systematische Stellung der Trigoniden und die Herkunft der Nayaden, Jahrb. der k. k. geol. Reichsanstalt, Bd. XLIII, pp. 1-28, Wien, 1893.

extremity sloping gradually, both above and below, and finally somewhat narrowly rounded; ventral margin broadly emarginate just behind the middle, then curving outward so that the shell's greatest height is about one-third of the length from the front, thence curving upward more rapidly toward the end of the shell; surface marked by distant radiating impressed lines, which are most prominent on the middle portion, and by obscure elevated radiating ridges, which are most distinct on the anterior half of the shell. In addition to these lines and ridges, which are as distinct on the internal cast as on the surface of the shell, some well-preserved casts show numerous very fine and closely arranged radiating lines that are visible only under a lens. The test is rather thin, and so fragile in its crystalline condition that in most cases it was entirely removed in breaking out the specimens.

Length of a specimen a little above the average size, 58 mm.; height at the beaks, 20 mm.; height near the anterior end, 23 mm.

The most salient features of the sculpture in this group seem to be generic characters, or at least they are repeated in many species. The present species may be readily distinguished from the three forms that have been described from the American Upper Cretaceous by its larger size and by differences in outline. It may be compared with *Solenomya costata* Tullberg (Bihang till K. Svenska Vet.-Akad. Handlingar, Bd. VI, No. 3, 1880, p. 11, pl. 1, figs. 15, 16), which occurs in the Aucella beds of Nova Zembla. Another related species of about the same size, but with different outline, is *S. torelli* Lindström (K. Svenska Vet.-Akad. Handlingar, Bd. VI, No. 6, 1865, p. 12, pl. 2, fig. 14), from the Aucella beds of Spitzbergen.

Locality and position.—Abundant in the small limestone, 3 miles northwest of Paskenta, Cal., and about 3,000 feet below the top of the Knoxville beds. Thirty-one specimens were collected—nearly all with both valves united. One small specimen, doubtfully referred to the same species, was obtained from the upper part of the Knoxville, 3 miles south of Lowerys.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23051.)

ASTARTIDÆ.

Genus ASTARTE Sowerby.

ASTARTE CORRUGATA n. sp.

Pl. VI, fig. 16.

Shell very small, subtriangular, moderately convex; beaks prominent, acute; cardinal margin sloping rapidly both in front and behind; ventral margin convex, most prominent behind the middle; surface marked by a few very prominent, distant concentric ridges and by fine lines of growth; ventral margin crenulated within.

Length of largest specimen seen, 5 mm.; height, 4 mm.; convexity of single valve, about 1 mm.

This species is based on several internal casts and molds of the exterior of valves, all of about the same size, but as they are associated with many young shells of other species they also may be immature individuals. Their form and sculpture make them easily distinguishable from all other species in the Pacific Coast Cretaceous.

Locality and position.—Shelton's ranch, 5 miles north of Paskenta, Cal., in the upper part of the Knoxville beds.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23052.)

ASTARTE CALIFORNICA n. sp.

Pl. VI, figs. 19–21.

Shell of medium size, subquadrate in outline, moderately convex; beaks prominent, subterminal, strongly curved forward; lunule ovate, deep, and well defined; front end descending rapidly from the beak with a concave outline above and somewhat narrowly rounded below; postero-cardinal margin sloping gently backward from the beak and joining the subtruncate posterior end by a broad curve; ventral margin broadly and regularly convex; surface marked by rounded concentric ridges, equaling or slightly exceeding the interspaces in width. A broadly rounded, somewhat obscure, umbonal ridge extends obliquely backward from the beak.

Length of the largest type, 23 mm.; height, 19 mm.; convexity of single valve, about 8 mm.

The free margins of the valves are crenulated within, and the hinge has two well-developed cardinal teeth in each valve.

In surface sculpture this species resembles *A. carlottensis* Whiteaves (Cont. to Can. Palæont., Vol. I, p. 154, and Mesozoic Fossils, Vol. I, p. 229, pl. 30, figs. 6, 6*a*, 6*b*), but its outline is very different. There is no other described species in the Lower Cretaceous of North America with which it needs to be compared.

Represented by eight valves.

Locality and position.—In the upper part of the Knoxville beds, near Stephenson's, on Cold fork of Cottonwood Creek, Tehama County, Cal.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23053.)

ASTARTE TRAPEZOIDALIS n. sp.

Pl. VI, figs. 17 and 18.

Shell of medium size, elongate subtrapezoidal in outline; beaks prominent, situated about one-third of the length behind the anterior end, which is somewhat contracted and narrowly rounded; cardinal margin behind the beaks nearly straight and parallel with the base; posterior end obliquely truncate; umbonal ridge rather prominent, broadly rounded, but fading out before reaching the postero-basal

angle; surface marked by prominent subangular concentric ridges that are somewhat narrower than the intervening furrows and by numerous fine, closely arranged lines of growth. The concentric ridges are less definite and regular in the later stages of growth, especially toward the posterior end. The lunule is deep and lanceolate in outline and the ligament is short and relatively small.

Length of the type, 25 mm.; height, 14 mm.; convexity of the two valves, 8 mm.

The elongate outline of this shell is unusual for an Astarte, but the other external features agree well with that genus, and internal casts (from another locality) show impressions of the hinge, which also seem to agree with it. The free margins of the shell are smooth within.

Locality and position.—The figured specimen is from the upper part of the Knoxville beds, 3 miles south of Lowerys, Tehama County, Cal. Nine other specimens, including the casts above mentioned, were collected by Mr. Jasper Palmer, jr., near Reiff, Lake County, Cal., where they occur in a limestone with *Pecten complexicosta*, *Turbo wilburensis*, etc. *Aucella crassicollis* was found near by, and the horizon is therefore regarded as about the same as at the other locality.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23054 and 23104.)

Genus OPIS Defrance.

OPIS CALIFORNICA, n. sp.

Pl. VII, figs. 1–4.

Shell of medium size, with the outline triangular when viewed from the side, and cordate in profile; beaks submedian, narrow, prominent, incurved, and approximate; surface divided by a sharply angular umbonal ridge into two distinct areas, of which the posterior one is nearly plane and so abruptly deflected that it is scarcely visible from the side view, although it embraces about one-third of the total surface of the valve; front and ventral margins regularly curved from the lunule to the end of the umbonal ridge, where it forms an angle of about 80° with the truncated and deflected posterior end; surface marked by fine lines of growth and more distant, irregular, concentric furrows; lunule cordate, large, and very deep, with its border narrowly rounded; behind the beak there is a well-defined depressed area, or escutcheon, resembling the lunule, but not quite so large nor so deep.

The hinge shows the characteristic structure of the genus, with a single very large striated triangular tooth in the right valve and two smaller ones in the left, of which the anterior is fused with the edge of the shell.

One of the eight valves in the collection is much more slender than any of the others, though it agrees perfectly with them in all other respects. This specimen (figs. 1–3) measures 27 mm. in height, 16 mm. in length, and 10 mm. in convexity. The corresponding dimensions of

the other figured specimen are 27, 20, and 11 mm., respectively. The largest valve collected is 35 mm. in height.

The genus Opis is very rare in American strata, only six species having been recorded from the Cretaceous, and four of that number, *O. bella* and *O. bicarinata* Conrad, *O. haleana* d'Orbigny, and *O. conradi* Gabb, are doubtful representatives of the genus. *O. vancouverensis* Whiteaves is much larger than *O. californica* and differs from it in every specific feature. *O. texana* Cragin (4th Ann. Rept. Geol. Surv. Texas, p. 196), described from an internal cast, is probably more closely related to our species, but it evidently differs in outline and other features. Under the name *Corbula triangulata*, Dr. J. G. Cooper has recently[1] described an Opis from the Chico beds on Point Loma, near San Diego, Cal. The figure is too poor to be recognizable, but through the courtesy of the secretary and trustees of the Mining Bureau I have been enabled to study a part of their Cretaceous collections from southern California, including this species, *Opis triangulata*, which is represented by the type and another much larger specimen. It has very nearly the outline of *O. californica*, but it has a much more strongly sculptured surface.

Locality and position.—In the upper part of the Knoxville beds, near Stephenson's, on Cold fork of Cottonwood Creek, Tehama County, Cal.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23055.)

LUCINIDÆ.

Genus LUCINA Bruguière.

LUCINA OVALIS n. sp.

Pl. XII, fig. 1.

Shell large, suboval, with both ends broadly and almost equally rounded, convex; beaks rather prominent, approximate; dorsal margin excavated in front of the beaks and gently convex behind; ventral margin forming a regular broad curve; surface marked by numerous fine elevated lines of growth and by larger, more irregular, undulations.

The type specimen measures 60 mm. in length, 45 mm. in height, and 27 mm. in convexity of both valves. All but one of the eight other specimens in the collection are smaller than the type.

The generic characters of Lucina are very well shown by this species. The hinge has two rather large cardinal teeth, and the laterals are also well developed. The anterior adductor muscular impression is long and narrow, extending backward considerably within the pallial line. The interior of the shell is rough and irregularly striated. The ligament is large and prominent.

Locality and position.—From the small limestone, 3 miles northwest of Paskenta, and about 3,000 feet below the top of the Knoxville beds. A fragmentary specimen probably belonging to this species was col-

[1] Cal. State Mining Bureau, Bull. No. 4, p. 49, pl. 2, fig. 42, San Francisco, 1894.

lected by Mr. Storrs at about the same horizon near Cooper's, on the south fork of Elder Creek, Tehama County, Cal.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23056.)

LUCINA COLUSAENSIS n. sp.

Pl. XI, figs. 4 and 5.

Shell large, elongate subovate in outline, convex; beaks prominent, approximate, situated a little in advance of the middle; dorsal margin slightly excavated in front of the beaks and sloping almost equally before and behind; anterior end broadly rounded; posterior end narrower and subangular below; ventral margin forming a broad curve; test rather thick; surface marked by numerous irregular coarse lines of growth.

Represented by two specimens, the larger of which measures 95 mm. in length, 68 mm. in height, and 40 mm. in convexity of the two valves united. The corresponding dimensions of the other specimen are 77 mm., 58 mm., and 34 mm., respectively.

This species also has a very large ligament and shows roughness and radiating striæ on the cast. The hinge and muscular impressions have not been seen, and it is referred to Lucina principally on account of its apparent relationship with *L. ovalis*. It is easily distinguishable from that species by its larger size, thicker test, coarser sculpture, more elongate form, and other differences in outline.

Locality and position.—The larger specimen was found associated with *Lucina ovalis* at the locality 3 miles southwest of Paskenta, Tehama County. The other was obtained in the white limestone, with *Rhynchonella whitneyi*, *Modiola major*, etc., near Wilbur Springs, on Sulphur Creek, Colusa County, Cal.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23057 and 23058.)

CYPRINIDÆ.

Genus CYPRINA Lamarck.

CYPRINA OCCIDENTALIS Whiteaves.

Pl. XII, fig. 2.

Cyprina occidentalis Whiteaves, 1884, Mesozoic Fossils, Vol. I, p. 227, fig. 10 in text.

Shell of medium size, with a thick test, subovate in outline, depressed; beak broad, rather prominent, and situated considerably in advance of the middle; dorsal border descending abruptly with a concave outline in front of the beak and sloping more gently behind, where it is straight or slightly convex; anterior end rather narrowly rounded; posterior end broader and subtruncate below; ventral margin forming a regular broad curve; surface marked by prominent but somewhat irregular concentric lines.

Length, 60 mm.; height, 50 mm.; convexity of single valve, about 16 mm.

The single specimen in our collection agrees so well with Whiteaves's species in outline and general proportion that I have little hesitation in identifying it, although it is smaller than the original. The hinge is not well preserved, but it evidently had large, heavy teeth.

Locality and position.—The type of the species came from the Queen Charlotte formation on the south side of Alliford Bay, Queen Charlotte Islands. Our specimen was found in the upper part of the Knoxville beds, near Stephenson's, on Cold fork of Cottonwood Creek, Tehama County, Cal.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23059.)

SOLENIDÆ.

Genus SOLECURTUS Blainville.

SOLECURTUS ? DUBIUS n. sp.

Pl. X, figs. 4 and 5.

Shell rather small, oblong, subequilateral, depressed; dorsal and ventral margins almost parallel; anterior end broadly rounded and somewhat narrower than the posterior end, which is obliquely subtruncate above; surface marked only by irregular lines of growth. In the young shell the beak is almost exactly median, but as the shell grows the posterior end becomes proportionally more elongate.

Length of the largest specimen collected, 36 mm.; height, 20 mm.

This form is very doubtfully referred to Solecurtus, as the hinge and other internal features are unknown.

Locality and position.—In the upper part of the Knoxville beds, near Stephenson's, on Cold fork of Cottonwood Creek, Tehama County, Cal.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23060.)

MYIDÆ.

Genus CORBULA Bruguière.

CORBULA ? PERSULCATA n. sp.

Pl. XI, fig. 3.

Shell small, subtriangular in outline; beak rather prominent; anterior end sloping rapidly from the beak, regularly rounded; postero-cardinal margin straighter and the posterior portion of the shell depressed and subtruncate; ventral margin gently convex; surface marked by fine lines of growth and by strong, regular, distant, concentric furrows, which extend posteriorly only to the obscure umbonal ridge.

Length, 5 mm.; height, 3 mm.

The generic position of this little species is somewhat doubtful, as it is known only from the type specimen, which is a cast of a left valve broken at the posterior end. Its form and surface sculpture, however, are sufficiently characteristic to make it easily recognizable.

Locality and position.—From the small limestone, 3 miles northwest of Paskenta, Cal., and about 3,000 feet below the top of the Knoxville beds.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23061.)

CORBULA FILOSA n. sp.

Pl. XI, figs. 1 and 2.

Shell small, oval, convex; beaks rather prominent, a little in advance of the middle; cardinal margin sloping almost equally from the beaks in front and behind; anterior end regularly rounded and narrower than the posterior end, which is also rounded, but more prominent above than below; ventral margin forming a broad curve; surface marked by slender filiform concentric lines, with somewhat broader interspaces. Some examples show an ill-defined subangular umbonal ridge extending from the beaks to the postero-basal margin.

Length of a large specimen, 19 mm.; height, 13 mm.; convexity of single valve, about 7 mm.

A provisional name is given to this form because it can not be referred to any of the described species from related deposits on the Pacific Coast. *Corbula concinna* Whiteaves (Mesozoic Fossils, Vol. I, p. 219, pl. 29, figs. 3, 3*a*), from the Queen Charlotte formation, is similar in some respects, but it differs essentially in outline, especially of the posterior portion, besides being a smaller form.

Locality and position.—In the upper part of the Knoxville beds, on Cold fork of Cottonwood Creek, near Stephenson's, Tehama County, Cal. Represented by twelve specimens.

(National Mnseum Catalogue, Mesozoic Invertebrate Fossils, 23062.)

SCAPHOPODA.

DENTALIIDÆ.

Genus DENTALIUM Linnæus.

DENTALIUM CALIFORNICUM n. sp.

Pl. XII, fig. 3.

Shell small, slender, rather strongly curved; aperture and cross section nearly circular; surface marked by about eight small angular longitudinal costæ, alternating with an equal number of fine lines.

Length of type specimen, 7 mm.; greatest diameter, 1 mm. The largest specimen seen is 11 mm. long.

This species may be distinguished from *Dentalium nanaimoense* Meek and *D. stramineum* Gabb, which occur in the Chico beds, by its smaller size, more arcuate form, and more delicate surface sculpture. It should be stated, however, that this species may be based on immature shells, since all known examples of it were found in a thin shaly layer full of a variety of small forms, some of which are certainly young shells of species that are found fully developed in adjacent strata.

Locality and position.—Upper part of the Knoxville beds on Shelton's ranch, 5 miles north of Paskenta, Cal.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23063.)

GASTROPODA.

PATELLIDÆ.

Genus HELCION Montfort.

HELCION GRANULATUS n. sp.

Pl. XII, fig. 4.

Shell depressed, conical, with the apex a little in advance of the middle and directed slightly forward; aperture elliptical; surface marked by numerous slightly wavy radiating costæ, which become somewhat broader on the posterior portion, crossed by rather closely arranged, impressed concentric lines, becoming more distant near the margin of large specimens.

The figured type measures 13 mm. in length, 9 mm. in breadth, and about 3 mm. in height. Another example that shows the surface ornamentation better, but is too much distorted by pressure for illustration, measures about three times these dimensions.

Locality and position.—Upper part of Knoxville beds, near Stephenson's, on Cold fork of Cottonwood Creek, Tehama County, Cal.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23064.)

FISSURELLIDÆ.

Genus FISSURELLA Bruguière.

FISSURELLA BIPUNCTATA n. sp.

Pl. XIII, fig. 8.

Shell small, elevated, conical, with the apex directed slightly forward and perforated; aperture subcircular; surface cancellated, the sculpture consisting of strong radiating ribs alternating with fine lines crossed in the interspaces between the ribs by stronger concentric lines, so that the interspaces when magnified have the appearance of radiating double rows of punctations.

The aperture of the type specimen, the only one known, measures 4 mm. by 6 mm., and its height is about 3½ mm.

The small size of this shell suggests that it may not be a full-grown individual, but if this should prove to be true there will probably be no difficulty in recognizing the species from its general form and its strongly marked sculpture. This is the first recorded occurrence of the genus Fissurella in the Mesozoic strata of North America.

Locality and position.—Upper part of Knoxville beds, near Stephenson's, on Cold fork of Cottonwood Creek, Tehama County, Cal.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23065.)

PLEUROTOMARIIDÆ.

Genus PLEUROTOMARIA Defrance.

PLEUROTOMARIA sp.

A large species represented by a single imperfect specimen was found in the upper part of the Knoxville beds, near Stephenson's, on Cold fork of Cottonwood Creek. It retains portions of the shell, but does not show much of the surface sculpture, though it was probably nearly smooth. The form is broadly conical, with a concave, deeply umbilicated base, on which are elevated revolving lines about 2 millimeters apart. The aperture is narrow and oblique, and the last whorl shows traces of a long narrow slit. The specimen is not well enough preserved to make an intelligible figure.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23066.)

TURBINIDÆ.

Genus TURBO Linnæus.

TURBO PASKENTAENSIS n. sp.

Pl. XII, figs. 5 and 6.

Shell of medium size, obliquely subovate; whorls, about five, regularly rounded and increasing rapidly in size, separated by a linear impressed suture; surface marked by rather distinct lines of growth and by subequal granulated revolving lines, of which there are about thirteen on the body whorl. Faint traces of these revolving lines are often visible on internal casts, especially on the body whorl of large specimens.

Height of the largest specimen seen, about 28 mm.; greatest breadth, 22 mm.

The species is represented by ten more or less imperfect casts, some of which retain enough of the shell to show the character of the surface sculpture. The aperture is not preserved in any of them, but the shell was evidently not umbilicated. It is referred to Turbo on account of its general form and surface sculpture, though from the material at

hand it is not possible to determine whether it had all the characteristics of that genus.

Locality and position.—Three miles northwest of Paskenta, Tehama County, Cal., in a small limestone about 3,000 feet below the top of the Knoxville beds.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23067.)

TURBO WILBURENSIS n. sp.

Pl. XII, fig. 15.

Shell of medium size, elongate ovate, consisting of five or six rounded whorls; suture linear, impressed; surface ornamented with small, elevated, slightly nodulose revolving lines, of which there are about twenty on the body whorl, and about nine are visible on the spire.

Height of the largest specimen, which is incomplete at the apex, 34 mm.; greatest breadth, 25 mm.

The species is represented by three specimens from a limestone in which the surface characters are not perfectly preserved. It is rather closely related to *T. paskentaensis*, from which it differs in its somewhat more slender form and the details of surface sculpture, having more numerous revolving lines of a different character. The aperture, also, is somewhat more produced in front.

Locality and position.—In the white limestone, near Wilbur Springs, on Sulphur Creek, Colusa County, Cal., where it is associated with *Rhynchonella whitneyi*, *Modiola major*, etc. Exact position in the Knoxville beds not determined.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23068.)

TURBO TRILINEATUS n. sp.

Pl. XII, fig. 12.

Shell small, obliquely ovate, consisting of about four rapidly increasing convex whorls; surface ornamented by three elevated, equidistant revolving lines that are visible on the spire, by seven or eight fainter and more closely arranged revolving lines on the lower half of the body whorl, and by rather distinct transverse striæ that give the shell an obscurely cancellated appearance, especially on the upper whorls. The aperture is subquadrate, and the shell is not umbilicated.

Height of the type specimen, 11 mm.; greatest breadth, 10 mm.

Represented by a single specimen. In drawing the figure the artist has erroneously made four equal revolving lines on the body whorl. The lowest of these should be much fainter.

In general form this species resembles the young of *T. paskentaensis*, but it is easily distinguished by the differences in sculpture. It is perhaps more closely related to *T. colusaensis*, described below, from

which also the details of sculpture and the great difference in size will serve to distinguish it.

Locality and position.—From a small lens of limestone in the upper part of the Knoxville beds, about 3 miles north of Lowerys, Tehama County, Cal.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23069.)

TURBO COLUSAENSIS n. sp.

Pl. XII, fig. 14.

Shell of medium size, elongate ovate, consisting of four or five rounded whorls; surface sculpture (as seen on the cast, retaining portions of the shell), consisting of four rather prominent, nodulose, revolving ridges, three of which are visible on the spire, of finer lines alternating with the ridges and covering the anterior half of the body whorl, and of rather prominent transverse lines which by intersecting the revolving ridges on the spire give the surface a coarsely reticulate or pitted appearance. Like all the other species here referred to the Turbinidæ, this shell is not umbilicated. Full outline of the aperture not preserved.

Represented by two specimens, the larger of which measures 26 mm. in height and 20 mm. in greatest breadth.

Compared with the preceding species (*T. trilineatus*), this form is proportionally more elevated and slender, and the details of the sculpture are different, though the general type of sculpture is the same in both.

Locality and position.—In the white limestone, near Wilbur Springs, on Sulphur Creek, Colusa County, Cal., where it is associated with *Rhynchonella whitneyi*, *Modiola major*, *Pecten complexicosta*, *Turbo wilburensis*, etc. Exact position in the Knoxville beds not determined, but this limestone is evidently interstratified with shales and sandstones bearing *Aucella piochii*.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23070.)

TURBO MORGANENSIS n. sp.

Pl. XII, fig. 13.

Shell of medium size, elongate ovate, consisting of about four rather rapidly increasing convex whorls; surface of the spire marked by two strong nodose revolving ridges that give the whorls a biangular appearance, crossed on the first two whorls by smaller transverse lines connecting the nodes; body whorl in front of the two ridges bearing four or five somewhat less prominent distant revolving lines. The surface when magnified also shows fine lines of growth and numerous faint revolving lines that cover the revolving ridges as well as the interspaces. The two prominent ridges are so placed that the anterior one is about on the middle of the body whorl, while the posterior one

is near the middle of the visible portion on whorls of the spire. The portion of the whorl behind (above) the posterior ridge is a nearly smooth slope, which sometimes shows a faint nodulose revolving line near the suture.

Represented by four internal casts and two natural molds of the surface, of which the largest specimen measures 20 mm. in height and 17 mm. in greatest breadth.

The most closely related of the Knoxville forms is *T. colusaensis*, which has the same general form and style of sculpture. The sculpture in *T. morganensis*, however, is coarser; it has two revolving ridges on the spire instead of three, and the revolving lines on the front half of the body whorl are much stronger and less numerous.

Locality and position.—Morgan Valley, Lake County, Cal., 1 mile northwest of Palmer's ranch, on road from Lower Lake to Knoxville, where it is associated with *Pecten complexicosta*, *Astarte trapezoidalis*, and *Atresius liratus* in the upper part of the Knoxville beds. Collected by Mr. Jasper Palmer, jr.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23071.)

TURBO ? HUMEROSUS n. sp.

Pl. XII, figs. 10 and 11.

Shell rather small, moderately elevated, composed of four or five volutions; whorls faintly angulated by two revolving lines or small carinæ, the lower of which is sometimes obsolete, and occasionally with a third line interpolated between them; posterior part of the whorls, above the upper revolving line, obliquely flattened; surface sculpture in addition to the carinæ consisting of fine revolving lines, that are more prominent toward the front of the body whorl, and of lines of growth. The growth lines are sinuous, directed slightly backward from the suture to the upper carina, where they have a tendency to form small tubercles, and thence curving gently forward; aperture broadly ovate, slightly produced below.

Length of an average specimen, 14 mm.; greatest breadth, 10 mm. Some individuals are more slender than this.

The true generic position of this species is doubtful. It is represented by ten imperfect specimens, none of which shows the full form of the aperture nor the character of the inner lip. In the best preserved examples the entire shell is replaced by calcite, thus retaining the sculpture in part.

Locality and position.—The figured types are from the upper part of the Knoxville beds, 3 miles north of Lówerys, Tehama County, Cal. Three specimens that seem to belong to this species were obtained in the white limestone with *Rhynchonella whitneyi*, *Modiola major*, *Turbo wilburensis*, etc., near Wilbur Springs, Colusa County, Cal.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23072 and 23073.)

Genus AMBERLEYA Morris and Lycett.

AMBERLEYA DILLERI n. sp.

Pl. XII, figs. 7–9.

Shell of medium size, rather slender turbinate; whorls, about six, sharply angulated by a strong tuberculate revolving carina, which on the body whorl is slightly above the middle; upper surface of the whorls, with a plane or slightly concave slope from the suture to the carina, marked by distinct, irregular lines of growth and on some specimens by one or two faint revolving lines; the portion of the whorl below the carina is rounded, and bears about seven distinct granulated revolving lines, of which the lower ones are smaller and more closely arranged, and only the upper one is visible on the spire, where it shows as a row of small tubercles just above the suture.

The species is represented by eighteen more or less fragmentary specimens, from which it is evident that adult shells measured not less than 35 mm. in height and about 25 mm. in greatest breadth.

Forms similar to this are referred by Fischer to the genus Amberleya, which was based on certain Oolitic species from England. In Zittel's Handbuch der Palæontologie, Amberleya is not recognized, because it is stated that the genus was not fully characterized, and the same forms are referred to Eunema. The Jurassic fossils belonging to this group were included by d'Orbigny in his genus Purpurina, and some of the species figured by him seem to be closely related to our California fossils. *Purpurina belia* (Pal. Fran. Terr. Jur. II, pl. 330, figs. 9, 10) especially has a very close resemblance to it in form and sculpture, and *P. ornata*, figured on the same plate, has almost exactly the same ornamentation as a fragment associated with the other specimens just described.

A species that seems to belong to the same group has been collected by Dr. Cooper Curtice in the Mariposa beds on Stanislaus River, opposite Bostwick's Bar, but it differs too much in details of sculpture to require minute comparison with this Knoxville form.

Locality and position.—From a small limestone, about 3,000 feet below the top of the Knoxville beds, 3 miles northwest of Paskenta, Cal.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23074.)

Genus ATRESIUS Gabb.

ATRESIUS LIRATUS Gabb.

Pl. XI, fig. 6.

Atresius liratus Gabb, 1869, Palæont. California, Vol. II, p. 169, pl. 28, fig. 50.

Original description.—"Shell small, thin, elongate; spire elevated, number of whorls unknown; whorls regularly convex, suture linear. Surface marked by about fourteen or fifteen subacute revolving ribs with concave interspaces, the space between the upper rib and the

suture twice as broad as those below; first rib minutely crenulated; the whole surface crossed by fine but distinct lines of growth. Aperture subovate, a little produced and subangular in front; outer lip simple, thin, and showing faint traces internally of the ribs on the surface; columella curved."

The type was a broken and apparently immature specimen "from the Shasta group, Colusa County, southeast of Hot Sulphur Springs." The fossils that I refer to the same species show considerable variation and are more nearly complete than the original. From these the following additional descriptive notes are drawn:

The whorls, which are six or seven in number, are regularly convex in some specimens, as in the type, while others are distinctly bicarinate, on account of the enlargement of the upper rib and the fourth one below it. In extreme cases the whorl is flattened between these two carinæ, but there are all variations between this extreme and the regularly rounded form with equal revolving lines. Usually only five lines are visible on the spire, but in a few specimens this number is almost doubled by the intercalation of intermediate lines.

Represented in the collection by about twenty five specimens, one of the largest of which measures 32 mm. in height and 18 mm. in greatest breadth.

The family affinities of this shell are rather doubtful. Gabb thought that it belonged to the Littorinidæ, but to me its relations seem to be rather closer with the Turbinidæ.

Locality and position.—The type came from southeast of Hot Sulphur Springs, Colusa County, Cal.; that is, from the neighborhood of Wilbur Springs, on Sulphur Creek, and therefore most probably from the Knoxville beds. The specimens I have studied, including the one figured, were collected by Mr. Jasper Palmer, jr., in limestone of the upper part of the Knoxville, 1 mile northwest of Palmer's ranch, Lake County, Cal., where it is associated with *Pecten complexicosta*, *Astarte trapezoidalis*, and *Turbo morganensis*. *Aucella crassicollis* was found in the shales near by.

The fossils from the Horsetown beds on Cold fork of Cottonwood Creek, that were doubtfully referred to this species in a previous publication,[1] belong to a distinct, undescribed species.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23075.)

TURRITELLIDÆ.

Genus TURRITELLA Lamarck.

TURRITELLA sp.

A single specimen that does not fully show its specific character was collected in the upper part of the Knoxville beds, near Stephenson's, on Cold fork of Cottonwood Creek. It is a small, very slender species, with subangular whorls that are most prominent just above the suture.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23076.)

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[1] Diller and Stanton, The Shasta-Chico Series, Bull. Geol. Soc. Am., Vol. V, p. 442.

PYRAMIDELLIDÆ.

Genus HYPSIPLEURA Koken.

HYPSIPLEURA ? OCCIDENTALIS n. sp.

Pl. XIII, figs. 3 and 4.

Shell small, slender, elongated, composed of about eight slightly convex volutions; surface ornamented by strong, curved, transverse costæ, and by very faint revolving lines crossed by lines of growth. The costæ are about ten or twelve on each whorl, slightly curved, with the convexity directed backward, largest at the upper end, which does not quite reach the linear suture above, and fading out just at the suture below, so that they do not cover the lower half of the body whorl. The most conspicuous of the revolving lines crosses the upper ends of the costæ, giving them a minutely tuberculate appearance.

Height of an average specimen, 11 mm.; greatest breadth, 4 mm.

This species seems to belong to the Mesozoic group formerly included in d'Orbigny's genus Chemnitzia, for which Koken[1] has proposed the name Hypsipleura. *Chemnitzia? vetusta* (Phillips), from the Great Oolite of England, has a close resemblance to our species.

Locality and position.—Abundant in the small limestone, 3 miles northwest of Paskenta, Cal., and about 3,000 feet below the top of the Knoxville beds.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23077.)

HYPSIPLEURA GREGARIA n. sp.

Pl. XIII, figs. 1 and 2.

Shell very small, rather slender, elongate, composed of about seven slightly convex whorls; suture impressed, linear; sculpture consisting of ten or twelve transverse costæ on each whorl extending entirely across the upper whorls of the spire, but shortened to mere tubercles forming a row on the upper margin of the last two or three whorls. Aperture obliquely ovate with a thin, sharp outer lip.

Height of an average specimen, 3 mm.; greatest breadth, a little more than 1 mm. It is possible that all the specimens collected are immature, since, in the layer of calcareous shale yielding them, there are many young shells of *Aucella crassicollis*, etc., but no larger individuals referable to this species were found.

This form is easily distinguished from the preceding by its smaller size, shorter costæ, and by the absence of revolving sculpture.

Locality and position.—In the upper part of the Knoxville beds, on Shelton's ranch, about 5 miles north of Paskenta, Tehama County, Cal., where it is very abundant in a single thin layer of shale.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23078.)

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[1] Zeitschr. deutsch. geol. Gesellschaft, Bd. XLIV, p. 201.

CERITHIIDÆ.

Genus CERITHIUM Adanson.

CERITHIUM PASKENTAENSIS n. sp.

Pl. XIII, figs. 5 and 6.

Shell small, composed of about five convex whorls, increasing rather rapidly in size; sculpture consisting of about twelve strong, transverse costæ on each whorl, crossed by fine, closely arranged revolving lines, of which nine or ten are visible on the spire; aperture elongate ovate, angular above and produced into a short canal below.

Height, 10 mm.; greatest breadth, 4 mm.

Locality and position.—From the small limestone, about 3,000 feet below the top of the Knoxville beds, 3 miles northwest of Paskenta, Cal. Represented by only the two imperfect specimens figured.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23079.)

CERITHIUM STRIGOSUM n. sp.

Pl. XIII, fig. 7.

Shell small, slender, consisting of nine or ten rounded whorls, surface ornamented by narrow, elevated, transverse costæ and by revolving lines. There are eight costæ on each whorl, so arranged that they form continuous varices the full length of the shell. Four of the revolving lines are visible on the spire.

Height, 6mm; greatest breadth, 2mm.

The species is known only from a natural mold of the outer surface, which does not show the form of the aperture.

Locality and position.—Shelton's ranch, 5 miles north of Paskenta, Cal., where it is associated with *Hypsipleura gregaria*, *Aucella crassicollis*, etc., in a layer of calcareous shale near the top of the Knoxville beds.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23080.)

CERITHIUM sp.

The collection from the upper part of the Knoxville beds, near Stephenson's, on Cold fork on Cottonwood Creek, contains fragments of another species of Cerithium, very distinct from those above described. It is a slender form with flattened whorls, ornamented by strong nodose revolving lines. The material is not sufficient to characterize it fully.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23081.)

APORRHAIDÆ.

Genus APORRHAIS Dillwyn.

APORRHAIS sp.

Cf. *Helicaulax bicarinata* Gabb, 1869, Palæont. California, Vol. II, p. 166, pl. 27, fig. 47.

Shell robust fusiform, consisting of four or five rapidly increasing whorls, which are obliquely flattened, so that the sides of the spire form a continuous slope; body whorl with two distinct carinæ, of which only the upper one is represented on the spire by a rather prominent raised line; surface also marked by numerous fine revolving lines; posterior canal extending to the apex of the spire; outer lip broadly expanded and wing-like, but its full outline and the anterior canal not preserved.

Height of a specimen, imperfect at both extremities, 24mm; diameter of body whorl, exclusive of expanded outer lip, 19mm.

The single imperfect specimen thus described was originally referred[1] to *H. bicarinata*, but after making more critical comparisons with the type of that species in the Philadelphia Academy of Sciences and with other collections from the Horsetown beds on Cottonwood Creek and in Tehama County, I think that it is a distinct species, though probably closely related.

The description and figure of *H. bicarinata* is slightly inaccurate. The whorls of the spire are distinctly angular, instead of plane, as shown in Gabb's figure. Better preserved specimens from the original locality in the Horsetown beds of Cottonwood Creek show that the wing has two long, slender processes, and the anterior canal also is slender and curved. It seems, therefore, to belong nearer to the typical Aporrhais than to Helicaulax.

Locality and position.—The specimen here described was collected by Mr. Storrs in the uppermost layers of the Knoxville beds, about 2 miles north of Lowerys, Tehama County, Cal.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23082.)

CEPHALOPODA.

AMMONOIDEA.

Genus PHYLLOCERAS Suess.

PHYLLOCERAS KNOXVILLENSIS n. sp.

Pl. XIV, figs. 1–4.

Cf. *Ammonites ramosus* (Meek) Gabb, 1864, Palæont. Cal., Vol. I, p. 65, pl. 11, fig. 12, 12*a*, and pl. 12, fig. 12*b*.

Not *Phylloceras ? ramosus* Meek, 1857, Trans. Albany Inst., Vol. IV, p. 45, and Bull. U. S. Geol. Surv. Terr., Vol. II, p. 371, pl. 5, figs. 1, 1*a*, 1*b*.

Shell rather large, discoid, moderately compressed, involute, with very small umbilicus; sides slightly convex; abdomen rather narrowly

[1] Bull. Geol. Soc. Am., Vol. V, p. 447.

rounded; surface ornamented by numerous, closely arranged, slightly flexuous linear ribs that begin as very fine lines at the umbilicus and increase in size to the abdomen, where they are slightly curved forward and are somewhat more narrow than the interspaces. The type specimen also shows several well-marked periodic constrictions.

The septa are closely crowded and very complex, the details being better shown in the tracing (fig. 3) than in a verbal description.

Greatest diameter of type, which is septate throughout, 112 mm.; height of aperture, 66 mm.; greatest breadth of same, 34 mm. Fragments from the same locality show that the species attained a much larger size.

A number of small specimens, like the one represented by fig. 4, have been collected at several localities in the Knoxville beds, and as they have about the same proportions as this species they are probably immature specimens of it. Being internal casts, the surface appears smooth, but the one figured retains faint remnants of the sculpture, consisting of fine lines.

It is with some hesitation that a new name is proposed for this form, though it is evidently distinct from Meek's *Ammonites ramosus*, which was based on a specimen from Comox, Vancouver Island. A comparison of the type of *A. ramosus* with *Phylloceras knoxvillensis* shows that the former is slightly more compressed, the umbilicus is proportionally somewhat larger, and there are no constrictions on the cast. The surface sculpture of both species consists of numerous fine lines, but they are more flexuous in *A. ramosus*, curving strongly forward near the umbilicus, while in *P. knoxvillensis* they are almost straight in that region. There are also important differences in the details of the septa, which are considerably more complex and finely divided in *A. ramosus* than in our form, although the latter is a much larger specimen. This difference is especially noticeable in the small siphonal saddle, which is deeply incised in the Vancouver species and almost simple and entire in *P. knoxvillensis*. The great difference in geological horizon of the two forms is also worthy of consideration, *P. knoxvillensis* occurring well down in the Knoxville beds and *A. ramosus* in the upper Cretaceous Chico beds. All the other species described from Comox, Vancouver, certainly belong to the Chico fauna, and, although *A. ramosus* has not been reported from Californian Chico beds, it has recently been discovered in the lowest Chico or uppermost Horsetown beds of southern Oregon by Mr. F. M. Anderson, through whose courtesy I have been permitted to examine a characteristic specimen and some of the interesting species associated with it.

Whiteaves[1] has treated *A. ramosus* as a synonym of *Phylloceras velledæ* Michelin, and this is a reasonable identification if all the European and Indian fossils figured under this name really belong to

[1] Mesozoic Fossils, Vol. I, pt. 2, p. 103.

one species. Quite recently, however, De Grossouvre[1] has proposed a new generic as well as specific name for the English Upper Cretaceous form that has been referred to *Phylloceras velledæ*. Until direct comparison of authentic European specimens of *P. velledæ* with these west coast fossils can be made I prefer to use Meek's name.

The form from Cottonwood Creek, Shasta County, Cal., referred by Gabb to *A. ramosus* in Palæontology of California, is also distinct from that species, though Meek himself acquiesced in the identification after seeing Gabb's sketches of his fossil. Near the original locality, in the neighborhood of Ono, on Cottonwood Creek, it is found only in the lower part of the Horsetown beds, where it is quite abundant. Gabb's figure shows a somewhat thicker, more convex form than any I have seen from there, and the details of the septa are not very accurate. It is much larger than any specimen of *P. ramosus* yet collected from the Chico and the sculpture is proportionally finer. The septum differs from that species in all its details, being much more like the septum of the type of *P. knoxvillensis*, though not quite so complex in the specimens I have examined. It also differs from *P. knoxvillensis* in its finer, less conspicuous sculpture, its somewhat more compressed form, and the entire absence of periodic constrictions. Perhaps these specimens from the Horsetown beds are only a variety of the Knoxville species—they are certainly closely related—but until the two forms are found in the same strata, and until the intermediate forms are found, it seems to me useful to treat them as distinct species, and I therefore propose the name *Phylloceras onoensis* for the Horsetown form. We then have three successive species, probably genetically related, in the Cretaceous of the Pacific Coast, viz: *P. knoxvillensis* n. sp. in the Knoxville, *P. onoensis* n. sp. in the Horsetown, and *P. ramosus* Meek in the Chico.

The generic reference of these species is not entirely satisfactory, because the saddles do not have the well developed phylliform terminations characteristic of typical species of Phylloceras. (Unfortunately my figure of the septum exaggerates this difference.) It seems to me, however, that their relations are closer with Phylloceras than with Desmoceras, to which somewhat similar forms have sometimes been referred. Possibly *P. ramosus* could be included in Grossouvre's genus Schlüteria, which seems to have been intended for Upper Cretaceous species only, but the three species are too closely related to permit their generic separation.

The figures of *Placenticeras fallax* Castillo and Aguilera[2] from the Aucella beds of Catorce, Mexico, show great resemblance to this species, excepting that the umbilicus is somewhat wider in the Mexican form.

Locality and position.—The type of *P. knoxvillensis* was collected by Mr. Cooper, about 1 mile northwest of his ranch, on the south fork of Elder Creek, Tehama County, Cal. The large fragments mentioned

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[1] Les Ammonites de la Craie supérieure, p. 216, Paris, 1893.

[2] Boletin de ia Comision Geológico de Mexico, No. 1, p. 17, pl. 8, figs. 1, 2, Mexico, 1895.

in the description and a small young specimen were collected by Mr. Storrs at the same place, where it is associated with *Aucella piochii*, *Hoplites storrsi*, etc. The horizon is about 3,000 feet below the top of the Knoxville beds. The small specimen figured is from the small limestone, on about the same horizon, 3 miles northwest of Paskenta. Similar small specimens have been collected in the neighborhood of Knoxville, Napa County, and near Wilbur Springs, Colusa County.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23083 and 23084.)

Genus LYTOCERAS Suess.

LYTOCERAS BATESI (Trask).

Pl. XIII, figs. 9–11.

Ammonites batesii Trask, 1855, Proc. Cal. Acad. Sci., Vol I, p. 40.
Ammonites batesii Gabb, 1864, Palæont. Cal., Vol. I, p. 67, pl. 13, figs. 16*a*, 16*b*.
? Ammonites batesii Gabb, 1869, Palæont. Cal., Vol. II, p. 132, pl. 20, fig. 9*a*, pl. 21, figs. 10*a*, 10*b*.
Ammonites crenocostatus Whiteaves, 1876, Mesozoic Fossils, Vol. I, p. 45, pl. 9, figs. 2, 2*a*.
Lytoceras batesi Whiteaves, 1884, Mesozoic Fossils, Vol. I, p. 202, pl. 27, fig 1.

This well-known species has been sufficiently described by the authors above referred to. It shows considerable variation in form, especially in the relative rapidity of increase by growth in the diameter of the whorls, and there is some variation in the amount of involution. I think, however, that the limits of the species should be more restricted than Gabb believed, and that it should not be made to include the form figured in volume 2 of the Palæontology of California, in which the earlier whorls are angular on the sides.

Well-preserved specimens nearly all show the crenulated costæ described by Whiteaves in *A. crenocostatus*, which he afterwards referred to *L. batesi*.

The peristome is greatly thickened and reflected in this species. This feature is indicated by the periodic constrictions on the internal cast, and it is well shown by a fragment of a large specimen recently collected in the Lower Horsetown beds, near Paskenta, Cal. (See Pl. XIII, figs. 9 and 10.) The whorl from which this fragment came was nearly 4 inches in diameter, and the whole shell must have exceeded a foot in diameter. The shell near the aperture has a thickness of 3 millimeters, which increases suddenly to 5 or 6 millimeters, and this thickened portion is abruptly reflected, first inward and then outward, so that a cross section of it has a narrow U-shape. The trumpet-shaped aperture of *Lytoceras immane* as described and figured by Neumayr[1] is of the same type, but somewhat more simple, as the peristome is only slightly reflected and expanded outward.

Locality and position.—The fragment showing part of the aperture is from the Lower Horsetown beds, about 3 miles north of Paskenta. The other figured specimen is from the Upper Knoxville beds, on Wil-

[1] Beiträge zur Paläontologie Oesterreich-Ungarns, Bd. III, pp. 101–103, Taf. 20, figs. 1–3, Wien., 1888.

cox's ranch, about 3 miles farther north. It is not uncommon at this horizon. Fragmentary specimens of the same or a closely related species have been collected much lower in the Knoxville beds, on south fork of Elder Creek, associated with *Aucella piochii*. It is most abundant and best preserved, however, in the Lower Horsetown beds, in Shasta and Tehama counties, from the north fork of Cottonwood Creek southward; also at Riddles, Oreg.; in Queen Charlotte Islands, etc.

Gabb also reports it from two localities in the Chico group, but this is probably an error in identification, as it has not been found in any of the later collections from those beds, and there are other forms there that, when not well preserved, might be mistaken for it.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23085 and 23086.)

Genus DESMOCERAS Zittel.

DESMOCERAS CALIFORNICUM n. sp.

Pl. XV, figs. 6 and 7.

Shell large, discoid, composed of rather narrow, slightly embracing, flattened whorls; abdomen rather broadly rounded; surface marked by slender, slightly curved ribs that cross the abdomen, but are somewhat less prominent there than on the sides. The ribs are usually simple, and are directed slightly forward in crossing the abdomen, but occasionally one bifurcates on the outer third of the side. The cast also shows occasional moderately deep periodic constrictions. Septa distant and not very complex, as shown in the tracing, distinguished especially by the very broad siphonal lobe.

The full dimensions of the species are not known, but the fragments that we have must have belonged to a specimen fully 10 inches in diameter. The largest whorl figured measures 45 mm. in height and 27 mm. in breadth. About half of each of the inner volutions is exposed in the umbilicus.

In general form this species is suggestive of Gabb's original figure of *A. breweri* (Palæont. Cal., Vol. I, pl. 10, fig. 7), but it differs from that figure in having smaller, much straighter, and more closely arranged ribs. Besides, as Gabb remarked, *A. breweri* "was originally described from several imperfect casts in sandstone, showing nothing but the surface characters and not all of those in a perfectly satisfactory manner," and "so distorted as to render it impossible to ascertain the shape of the section of a whorl, or even to show the amount of enveloping of the whorls." It is very probable, therefore, that Gabb was right in referring to this species the more perfect specimens from the same locality that are described and figured in the second volume of Palæontology of California. These are much more involute than the original figure and are not at all closely related in either form or septa to *Desmoceras californicum*, which has been compared with the large collection of *A. breweri* from Horsetown.

Locality and position.—About 3 miles north of Paskenta, Cal., and one-half mile east of Henderson's, associated with *Aucella crassicollis*, var., in beds about 1,500 or 2,000 feet below the top of the Knoxville. Represented by three other fragments besides those figured, probably all belonging to one individual. Collected by Mr. Storrs.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23087.)

DESMOCERAS ? sp.

Another species probably belonging to this genus is represented by several fragments from the uppermost Knoxville beds, from 2 to 4 miles north of Lowerys, Tehama County, Cal. It is much more involute than the preceding species, and is marked by numerous rather closely arranged ribs.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23088.)

Genus OLCOSTEPHANUS Neumayr.

OLCOSTEPHANUS (SIMBIRSKITES) MUTABILIS n. sp.

Pl. XV, figs. 1–5.

Cf. *Olcostephanus discofalcatus* Lahusen, Verhandl. Russ. Kais. Min. Gesellschaft, 2d ser., Bd. IX, p. 67, pl. 7, figs. 2–4; Pavlow, Bull. Soc. Nat. Moscou, 1890, pl. 6, fig. 1; Idem, 1891, pl. 18, fig. 2.

Cf. *Olcostephanus quatsinoensis* Whiteaves, Trans. Roy. Soc. Canada, Vol. I, sec. 4, p. 82, fig. 1, and *Scaphites quatsinoensis* Whiteaves, Cont. Can. Palæont., Vol. I, p. 158, pl. 21, fig. 2.

Cf. *Olcostephanus potosinus* Castillo and Aguilera, 1895, Boletin de la Comision Geológico de Mexico, No. 1, p. 36, pl. 7, fig. 2.

Shell rather small, discoid, involute; volutions narrowly rounded on the abdomen, slightly convex on the sides, and regularly rounded into the umbilicus, in which only a small portion of the preceding whorl is visible; surface ornamented by narrow, prominent, slightly sinuous ribs that originate on the margin of the umbilicus, usually divide about the middle of the side into two to four branches, and thence cross the abdomen, where they are strongly curved forward. The ribs vary greatly in different specimens and at different stages of growth in the same specimen. In one of those figured the most of the ribs simply bifurcate once, though occasionally one divides into three branches, and a few are simple; but on the outer third of the last whorl the ribs starting from the umbilicus are larger and more widely separated, and after passing about half way across the side they are each broken up into four or five small ribs, so that on the abdomen the ribs are finer and more closely arranged than they are in the same region of the earlier portions of the shell. In some of the specimens this style of sculpture seems to be developed at an earlier stage, while in others nearly all the ribs trifurcate, but after studying a series of about forty specimens I can not make these variations of specific importance. Internal casts also show several periodic constrictions on each volution.

The larger of the figured specimens is about of the average size, though it is septate throughout. Its dimensions are: Greatest diameter, 52 mm.; umbilicus, 11 mm.; end of last volution, 26 by 16 mm. All the specimens are more or less distorted, and none shows the complete septum clearly. The enlarged sketch (fig. 2) shows pretty accurately the form of the septum, excepting the siphonal lobe, which was not seen on any of the specimens.

The Russian species with which I have compared this one, and which seems to be really very closely related, comes from the Neocomian of Simbirsk and Worobiewo, and is also reported from England. It belongs to the group of Olcostephanus, for which Pavlow has proposed the name Simbirskites.

Scaphites quatsinoensis Whiteaves, which was originally described as an Olcostephanus, comes from the same horizon as our species on the northern end of Vancouver Island, and in size, general form, and style of ornamentation, especially in the variations described in the later publication referred to, it is quite comparable with *O. mutabilis*, but this resemblance is probably only superficial, as our specimens certainly are not Scaphites.

The fragmentary specimen of *Olcostephanus potosinus* Castillo and Aguilera, from the Aucella beds of Catorce, Mexico, shows the same type of sculpture as *O. mutabilis*.

Locality and position.—On Shelton's ranch, 5 miles north of Paskenta, Cal., in the upper part of the Knoxville beds.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23089.)

OLCOSTEPHANUS (POLYPTYCHITES) TRICHOTOMUS n. sp.

Pl. XVI, fig. 1.

Cf. *Ammonites polyptychus*, Keyserling, 1864, Reise in das Petschora-Land, p. 327, pl. 21, figs. 1–3, and pl. 22, fig. 9.

Shell rather large, moderately involute, with rounded whorls that are nearly as broad as high; surface ornamented by strong, slightly curved ribs that arise on the edge of the umbilicus and divide about the middle of the side into two branches, the posterior of which usually again soon divides. On the abdomen these divided ribs are about half as broad as the interspaces.

The specimen in hand is so badly crushed and distorted that a full specific description can not be given, but the surface sculpture will readily distinguish it from all of its associates and make it easily identifiable when good specimens are found.

Ammonites polyptychus, which Eichwald regarded as a synonym of *A. bidichotomus*, seems to be a closely related species, but is apparently somewhat more involute. This and several similar forms from the lowest Cretaceous and uppermost Jurassic beds of Europe are grouped together by Pavlow [1] under the subgeneric name of Polyptychites.

[1] Pavlow and Lamplugh, Argiles de Speeton et leurs Équivalents, pp. 118–130 (from Bull. Soc. Nat. Moscou, 1891).

Locality and position.—Two miles south of Lowerys, Tehama County, Cal., in the uppermost layers of the Knoxville beds.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23090.)

Genus HOPLITES Neumayr.

HOPLITES HYATTI n. sp.[1]

Pl. XVI, fig. 2.

Shell of medium size, discoid, slightly involute; whorls, about four or five, flat or very gently convex on the sides, with the abdomen slightly flattened, except on the last third of the outer volution; surface marked by numerous slightly curved ribs, the most of which bifurcate on the outer third of the volution and cross the abdomen, though not quite so prominent there as on the sides. In the earlier stages of growth (so far as they can be seen in the specimen) the ribs are prominent and closely arranged, but on a part of the last volution they take on a senile character, becoming more distant, broader, rounded, and less conspicuous. The aperture has long lateral ears, 12 mm. wide, and projecting nearly an inch (22 mm.) beyond the general outline of the aperture. Septum unknown.

The greatest diameter of the type specimen is about 90 mm., and the aperture measures 30 mm. in height. The shell is somewhat flattened by pressure, but the normal breadth of the aperture in a specimen of this size is probably not more than 12 or 15 mm.

This species is related to *H. tenochi* Felix[2] and *H. xipei* Felix[2] from the Neocomian near Tlaxiaco, in the State of Oaxaca, Mexico, but it differs from both of these in the minor details of sculpture and in the form of the aperture, though in the latter feature it resembles *H. tenochi* very closely. Its nearest relative among the Knoxville forms is *Hoplites storrsi*, from which it differs sufficiently in sculpture to be easily distinguished when adult specimens are compared.

Locality and position.—West of Riddles, Oreg., on the road to the nickel mines, associated with *Aucella crassicollis*, in the upper part of the Knoxville beds. Collected by Mr. W. Q. Brown.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23091.)

HOPLITES STORRSI n. sp.

Pl. XVII, figs. 1 and 2; Pl. XVIII, fig. 5.

Shell of medium size, discoid, moderately involute, each whorl concealing about half of the preceding one; whorls very slightly convex on the sides, the greatest convexity being near the umbilicus; abdomen somewhat flattened; surface marked by numerous slender, slightly curved elevated ribs that originate on the margin of the umbilicus,

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[1] A note on this specimen by Professor Hyatt is published by Mr. Diller in Bull. Geol. Soc. Am., Vol. IV, p. 212, 1893.

[2] Palæontographica, Bd. XXXVII, pp. 186, 187, pl. 28, figs. 1–3 and 6.

usually bifurcate a little beyond the middle of the side, and become obsolete in crossing the flattened abdomen; septa crowded and very complex, as shown in the figure.

The type specimen, which is septate throughout, measures 110 mm. in its greatest diameter, and the aperture measures 48 by 30 mm.

This species is not quite so compressed as *H. hyatti*, and the sculpture consists of narrower and more elevated ribs. It has a closer resemblance to one of Felix's figures of *H. tenochi*,[1] from the Neocomian of Mexico.

Related forms, such as *Hoplites angulicostatus* (d'Orbigny), occur in the Neocomian of Europe, and the same group of Hoplites is represented in the Upper Jurassic (Tithonian) by a number of species, such as *H. calisto* (d'Orbigny), *H. carpathicus* Zittel, and others, that have a close resemblance to our species. Those from the Tithonian have recently been figured by Kilian.[2] A similar species has also been described by Behrendsen[3] under the name *Hoplites calistoides*, from the Tithonian of the eastern slope of the Argentine Cordillera. The form from the Aucella-bearing series of Catorce, Mexico, figured by Castillo and Aguilera[4] under the name *Hoplites calisto* var., is very closely related to *H. storrsi*, and may be identical with it. *Hoplites angulatus*, described below, is another related species, differing in details of sculpture, and slightly in proportion of whorls, as will be pointed out in describing it.

Locality and position.—One mile northwest of Cooper's, on south fork of Elder Creek, Cal., about 3,000 feet below the top of the Knoxville beds. Represented by a single specimen, which was collected by Mr. James Storrs.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23092.)

HOPLITES ANGULATUS n. sp.

Pl. XVIII, figs. 3 and 4.

Shell small, discoid, slightly involute, each volution enveloping about one-third of the preceding one; volutions flattened on the periphery, slightly convex on the sides, and descending abruptly into the broad and rather deep umbilicus; surface marked by strong curved ribs arising on the margin of the umbilicus and passing to the abdomen, where they are interrupted, or at least are less strongly marked. There is a slight tendency to form nodes on the margin of the umbilicus and also on the periphery at the other end of the ribs. Some of the ribs are simple, but more than half of them bifurcate after crossing from one-half to two-thirds of the distance from the umbilicus to the periphery.

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[1] Palæontographica, Bd. XXXVII, pl. 29, fig. 1.

[2] Boletin de la Comision del Mapa Geologico de España, Tomo XIX, pp. 615–626, pls. 5–10, Madrid, 1893.

[3] Zeitschr. deutsch. geol. Gesellschaft, Bd. XLIII, p. 402, pl. 23, figs. 1*a*, 1*b*.

[4] Boletin de la Comision Geológico de Mexico, No. 1, p. 38, pl. 11, fig. 2.

There are also a few interpolated simple ribs that begin about the middle of the side. Septum unknown.

The immature figured type measures 40 mm. in its greatest diameter; the aperture is 18 mm. high and 12 mm. broad, and the umbilicus is 11 mm. in diameter.

This species is evidently related to *Hoplites storrsi*, but its whorls are proportionally somewhat more convex, its sculpture is relatively coarser, with broader and more strongly curved ribs, and the border of the umbilicus is more angular. This character of the umbilicus, with its vertical walls, will readily separate it from all the associated forms in the Knoxville beds. *Hoplites crassiplicatus* is less involute and has stronger and fewer ribs that bifurcate nearer the abdomen than in this species.

The most closely related European species that I have seen figured is *H. amblygonius* Neumayr and Uhlig,[1] from the Neocomian of Germany. Pavlow[2] has figured a small specimen referred to the same species from Speeton, England, which is so much like our figure that it would be difficult to point out any essential difference.

Locality and position.—Shelton's ranch, about 5 miles north of Paskenta, Cal., where it is associated with *Olcostephanus mutabilis*, *Aucella crassicollis*, and many other forms.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23093.)

HOPLITES CRASSIPLICATUS n. sp.

Pl. XVIII, fig. 8.

Shell rather small, discoid, very slightly involute; whorls compressed, descending rather abruptly into the umbilicus and flattened on the abdomen; surface ornamented by relatively large, distant ribs that arise on the edge of the umbilicus, and nearly all bifurcate after passing over about two-thirds of the distance to the periphery, on which they are interrupted. On the inner whorls the point of bifurcation of the ribs is just visible in the umbilicus.

The species is represented by a single fragment, showing parts of three whorls, of which the larger measures 17 by 13 mm. in cross section.

This species may be distinguished from all the other Knoxville Hoplites by its less involute form and relatively coarser, more distant ribs.

The Russian Lower Volgian *Hoplites rjasensis* Lahusen, as figured by Nikitin,[3] seems to be a related species, distinguished mainly by its more involute form. In general aspect and in ornamentation of the sides *H. crassiplicatus* has some resemblance to the young of *Perisphinctes skidegatensis* Whiteaves, from Queen Charlotte Islands, but of course they are not closely related.

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[1] Palæontographica, Bd. XXVII, p. 168, pl. 36, fig. 1; pl. 37, fig. 1, etc.

[2] Bull. Soc. Nat. de Moscou, 1891, pl. 17, fig. 6.

[3] Vestiges de la Période Crétacée dans la Russie Centrale, pl. 1, figs. 1–3.

Locality and position.—About 3 miles north of Paskenta and one-half mile east of Henderson's, associated with *Aucella crassicollis*, var., *Desmoceras californicum*, etc., in beds 1,500 or 2,000 feet below the top of the Knoxville beds.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23094.)

HOPLITES DILLERI n. sp.

Pl. XVIII, figs. 6 and 7.

Shell small, discoid, somewhat involute; whorls convex on the sides, flattened on the periphery, and regularly rounded to the broad umbilicus, whose diameter is a little more than one-third of that of the entire shell; surface ornamented by numerous slender but sharply elevated ribs that arise in the umbilicus, are almost straight for about two-thirds of the distance across the whorl, and then divide, sometimes into two, but frequently into three, branches that curve strongly forward and are interrupted by a narrow furrow on the rather broad abdomen. The details of the septa can not be determined from the specimens at hand.

The type specimen, consisting of about four septate volutions, measures 31 mm. in greatest diameter, and the aperture is 13 mm. in height by 11 mm. in breadth.

This species is easily separated from the other species of Hoplites in the Knoxville by its more convex volutions and by the finer ribs, many of which are trifurcate.

Locality and position.—The type was collected by Mr. J. S. Diller, 3 miles west of Lowerys, Tehama County, Cal., associated with *Aucella piochii* var. *ovata*, in beds considerably below the top of the Knoxville. A smaller fragmentary specimen was obtained by Mr. Storrs at about the same horizon, 1 mile northwest of Cooper's, on south fork of Elder Creek, and another similar speciman at a higher horizon, 3 miles north of Paskenta and one-half mile east of Henderson's.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 21573.)

Genus PERISPHINCTES Waagen.

PERISPHINCTES sp.

One, or possibly two, species that seems to belong to this genus is represented by imperfect specimens from Cooper's ranch, on the south fork of Elder Creek, Tehama County. They are too obscure for specific description.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23099.)

Genus DIPTYCHOCERAS Gabb.

DIPTYCHOCERAS ? sp.

Cf. *Diptychoceras lævis* Gabb, 1869, Palæont. California, Vol. II, p. 144, pl. 25, figs. 21, 21*a*, 21*b*.

A number of smooth, straight fragments of an Ammonoid that seems to be identical, so far as the features are preserved, with Gabb's species,

which is common in the Horsetown beds. None of the Knoxville specimens collected shows the two or three limbs connected, though in one specimen there are two portions lying in contact and parallel that probably belong to one individual.

Locality and position.—In the Knoxville beds this form was found only on Shelton's ranch, 5 miles north of Paskenta, in the upper part of the Knoxville.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23100.)

Genus CRIOCERAS Leveillé.

CRIOCERAS LATUS Gabb.

Crioceras latus Gabb, 1864, Palæont. California, Vol. I, p. 76, pl. 15, figs. 25, 25*a*, 25*b*, and pl. 14.

A characteristic fragment of one of the outer volutions was collected from the uppermost Knoxville beds, with *Aucella crassicollis*, etc., 2 miles south of Lowerys, Tehama County. A small specimen showing the inner volution was found in the basal Horsetown beds immediately overlying the Knoxville, about 2 miles farther south. The species was originally described from the Horsetown beds, on the north fork of Cottonwood Creek, Shasta County.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23101.)

Genus APTYCHUS Meyer.

APTYCHUS ? KNOXVILLENSIS n. sp.

Pl. XVIII, figs. 1 and 2.

This fossil, which is somewhat doubtfully classified as the Aptychus of an Ammonite, is an impression of a symmetrical, gaping, bivalved body, with the two valves united throughout the entire length of the shorter diameter, but not showing any Molluscan hinge structure. In the single specimen collected the two valves join each other at an angle of about 60°. Only one valve is preserved so as to show the entire outline, which is elongate subquadrate, resembling some of the simpler forms of Perna. The surface is marked by obscure concentric undulations.

The larger diameter, from the line of junction of the two valves to the opposite free end, is 32 mm., and the shorter diameter, at right angles to this, is 21 mm.

Locality and position.—On road from Reed to Ryal quicksilver mines, near Knoxville, Napa County, Cal., where it is associated with *Aucella piochii*. Collected by Dr. G. F. Becker.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23095.)

BELEMNITIDÆ.

Genus BELEMNITES Lister.

BELEMNITES IMPRESSUS Gabb.

Pl. XX, figs. 1–5.

Belemnites impressus Gabb, 1864, Palæont. California, Vol. I, p. 58, pl. 9, figs. 2, 2*a*; 1869, idem, Vol. II, p. 129; Whiteaves, 1883, Proc. and Trans. Roy. Soc. Can., Vol. I, sec. 4, p. 82.

Guard large, moderately long, robust, subcylindrical, tapering for about one-fourth of its length to a rather blunt point; ventral side with a broad, deep furrow that is deepest about at the apex of the phragmacone and gradually fades out toward the ends of the guard; phragmacone large, with numerous short chambers, its apical angle about 18°, or in some specimens slightly greater. The apical angle of the phragmacone is about the same whether measured in transverse or dorso-ventral direction.

Length of an imperfect specimen (fig. 5), 128 mm.; greatest lateral diameter, 23 mm.; dorso-ventral diameter, 22 mm. The other specimen figured (figs. 3 and 4) has a somewhat more robust form, but evidently belongs to the same species.

This species belongs to the section Infradepressi of Pavlow,[1] which includes *B. absolutus* Fischer and *B. magnificus* d'Orbigny, of the Russian Upper Jurassic, together with a number of other Jurassic and Neocomian species, all of which are regarded by Pavlow as boreal types.

Locality and position.—Very abundant in the upper part of the Knoxville beds, and in the overlying Horsetown beds, ranging through several thousand feet of strata. All of the specimens figured are from the Lower Horsetown beds, because it happens that all of the best preserved examples in our collection are from that horizon. Fig. 1 represents a specimen from the Bald Hills, near Wilcox's, Tehama County, and all the others are from the neighborhood of Ono, on the north fork of Cottonwood Creek, Shasta County, Cal. Many fragmentary specimens, well enough preserved for identification, were collected with *Aucella crassicollis* on Shelton's ranch, north of Paskenta; at the locality 2 miles north of Lowerys, Tehama County, and elsewhere.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23096 and 23097.)

BELEMNITES TEHAMAENSIS n. sp.

Pl. XIX, figs. 1–3.

Guard very long, slender, subcylindrical, tapering gradually to an acute point; ventral side with a very shallow, faint groove that begins near the point and, in passing up on the guard, broadens until it is

[1] Argiles de Speeton, pp. 89–95, from Bull. Soc. Nat. de Moscou, 1891.

represented only by a flattening of the ventral surface; section subcircular; apical angle of phragmacone, as determined from fragment showing part of alveolar cavity, about 25°.

Length of type specimen, which does not contain any part of the alveolus, 137 mm.; diameter of anterior end, 18 mm.

This species belongs to the same section as *B. impressus*, from which it is easily distinguishable by its much more slender form, greater length, more acute apex, and more nearly circular cross section. There is a related species (*B. inæquilateralis* Eichwald ?) in the National Museum from the Aucella-bearing beds of Herendeen Bay, Alaska, and similar forms occur in the Upper Jurassic of Europe, such as *B. obeliscoides* Pavlow.

Locality and position.—Abundant near Cooper's ranch, on the south fork of Elder Creek, Tehama County, Cal., and at the same horizon elsewhere in that region, associated with *Aucella piochii* var. *ovata*.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23098.)

BELEMNITES sp.

In the upper part of the Knoxville beds there is another species of Belemnites, represented in our collections by fragments. It apparently has about the form of *B. tehamaensis*, but the alveolus, with an apical angle of about 26°, is inclined toward the ventral side so that its apex is midway between the center and the ventral side, making the axis of the guard very eccentric.

This form occurs on Shelton's ranch, 5 miles north of Paskenta, Cal., associated with *B. impressus*, *Aucella crassicollis*, *Olcostephanus mutabilis*, etc.

(National Museum Catalogue, Mesozoic Invertebrate Fossils, 23103.)

PLATES.

PLATE I.

PLATE I.

Page.

RHYNCHONELLA SCHUCHERTI n. sp 31

Figs. 1, 2, 3. Dorsal, ventral, and profile views of an average specimen.

Fig. 4. Ventral valve of a more convex example.

RHYNCHONELLA WHITNEYI Gabb 32

Figs. 5, 6. Dorsal views of two young shells showing elongate form of early stages.

Figs. 7, 8. Dorsal and front views of a medium-sized, coarsely plicate specimen.

Fig. 9. Ventral view of a large, coarsely plicate specimen. (The unnaturally steep slopes on each side of the beak are in part accidental.)

Fig. 10. Similar view of the more finely plicate variety.

TEREBRATULA sp 33

Fig. 11. Cast of a ventral valve.

TEREBRATELLA CALIFORNICA n. sp 33

Fig. 12. Ventral valve.

Fig. 13. Dorsal valve.

All figures on this plate are natural size.



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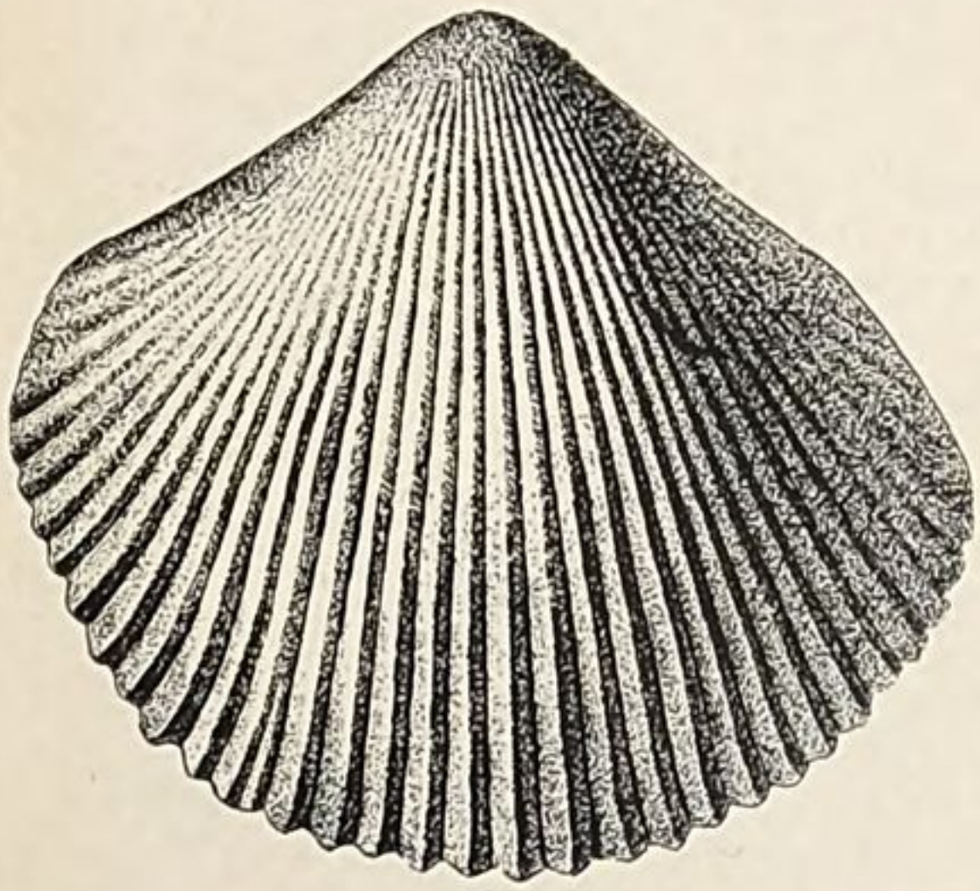
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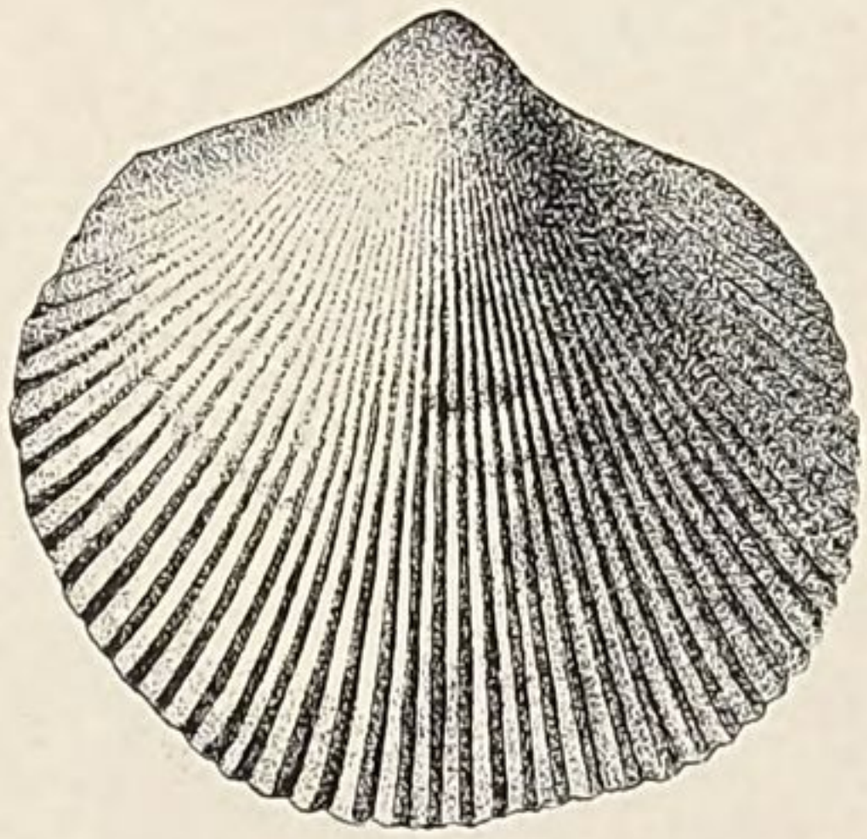
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BRACHIOPODA.

PLATE II.

PLATE II.

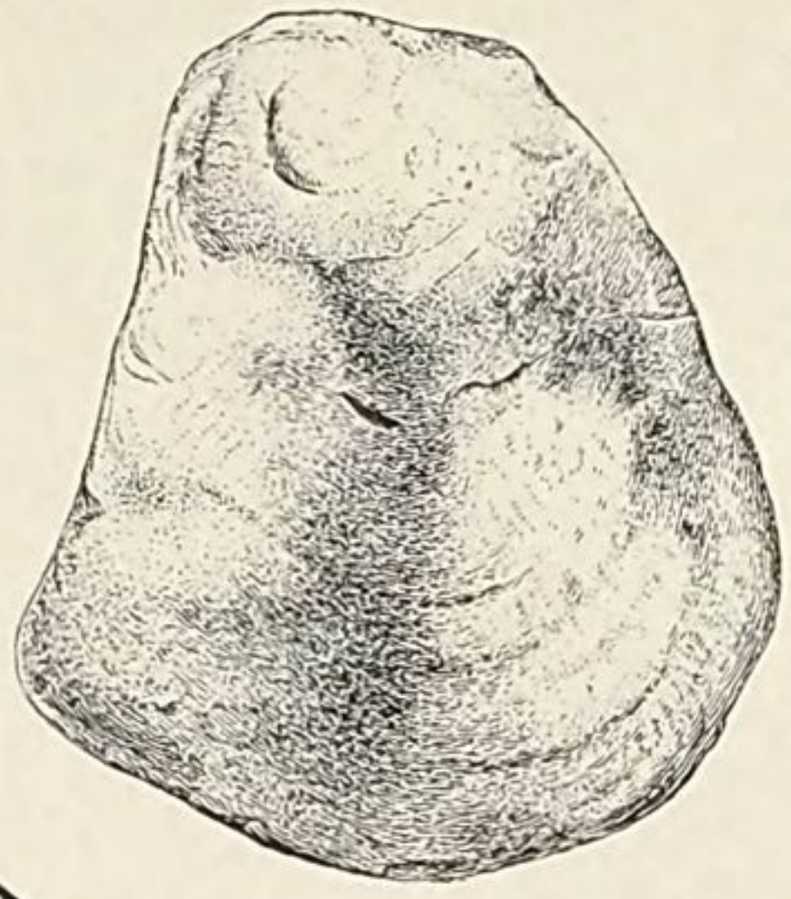
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OSTREA sp. Cf. *O. skidegatensis* Whiteaves 34
Fig. 1. A small upper valve.
ANOMIA SENESCENS n. sp 35
Fig. 2. Upper valve.
SPONDYLUS FRAGILIS n. sp 35
Fig. 3. Small left valve.
LIMA MULTILINEATA n. sp 36
Fig. 4. Small right valve.
Fig. 5. Large imperfect right valve.
PECTEN sp 37
Fig. 6. Cast of a left valve.
PECTEN COMPLEXICOSTA Gabb 37
Fig. 7. A medium-sized right valve.
Fig. 8. A smaller, somewhat distorted right valve.
Fig. 9. A medium-sized left valve.
The outer surface of the shell is not preserved in any of these specimens.
PECTEN CALIFORNICUS Gabb ? 36
Fig. 10. Small right valve, enlarged two diameters.
MYOCONCHA AMERICANA n. sp 48
Fig. 11. Right valve.
PINNA sp 49
Fig. 12. Right valve of a young specimen, enlarged four diameters.

Unless otherwise stated the figures are natural size.



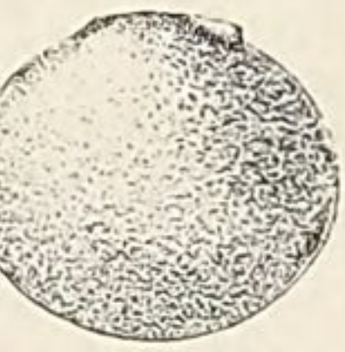
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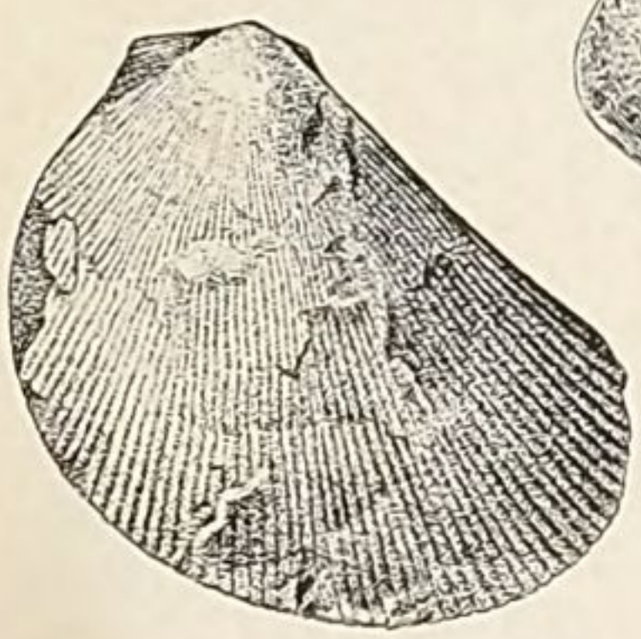
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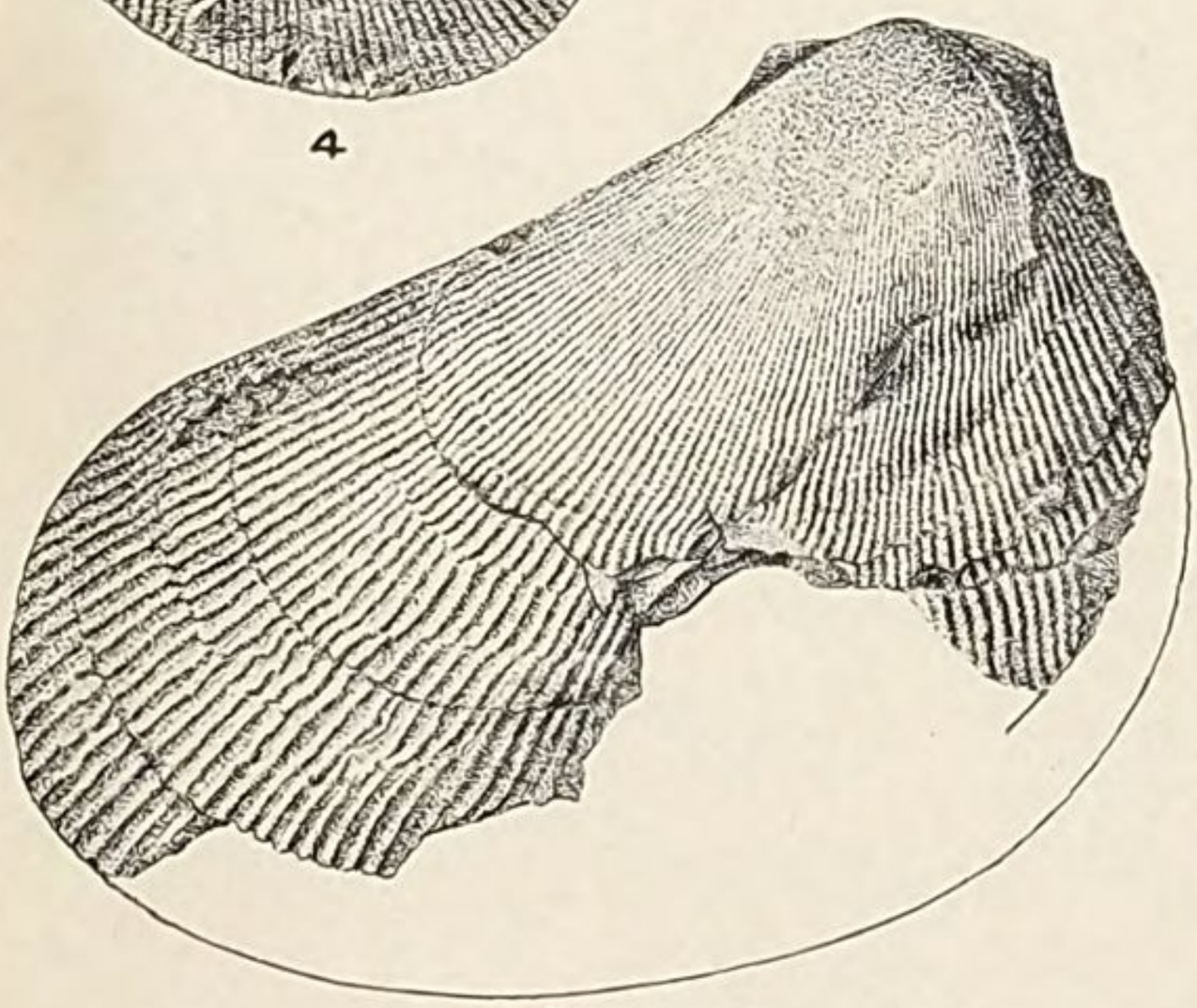
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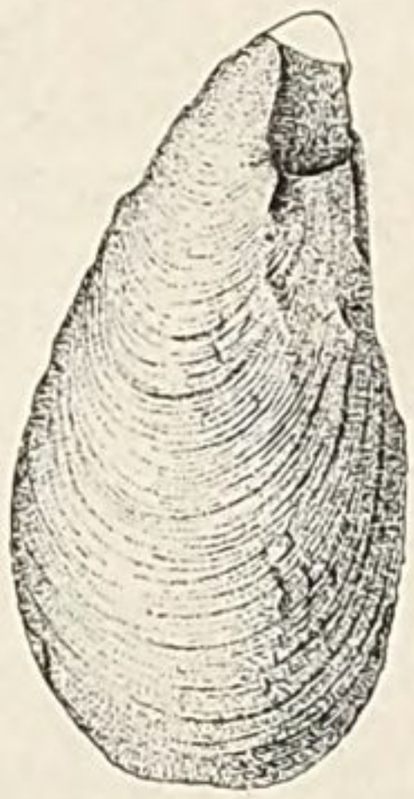
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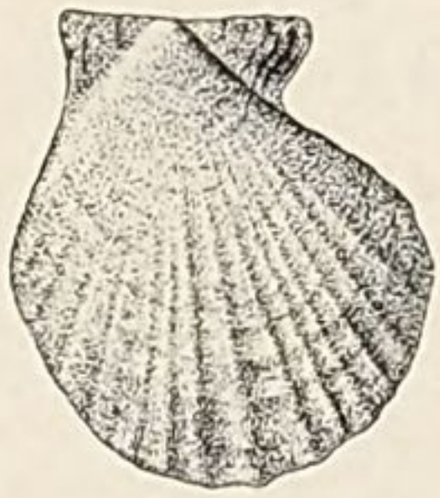
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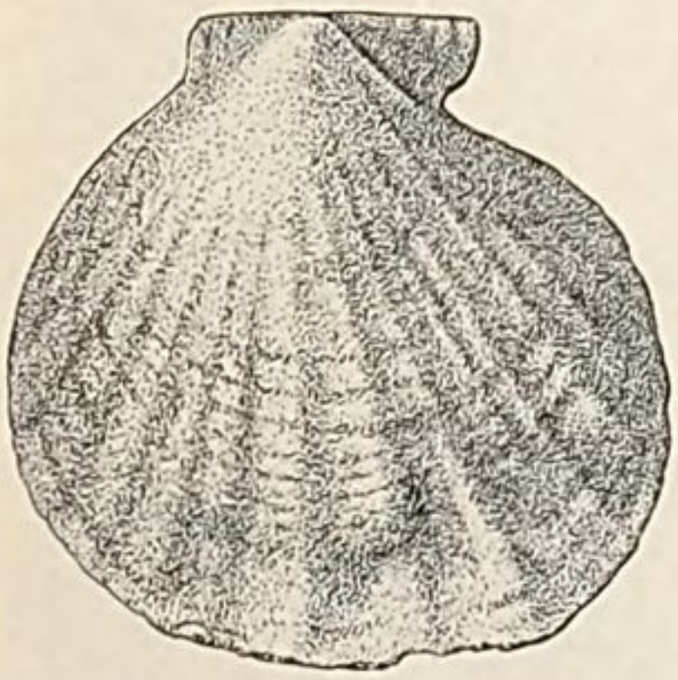
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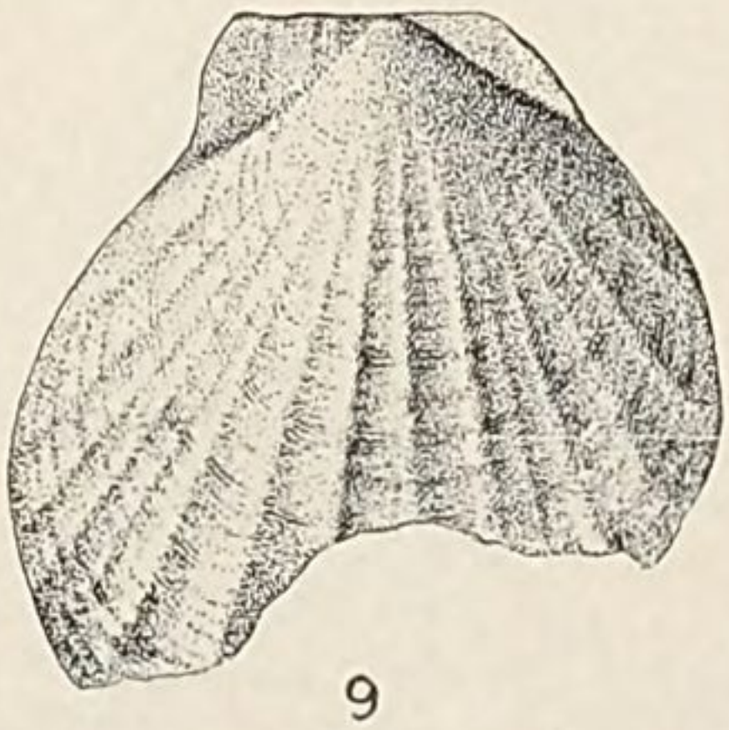
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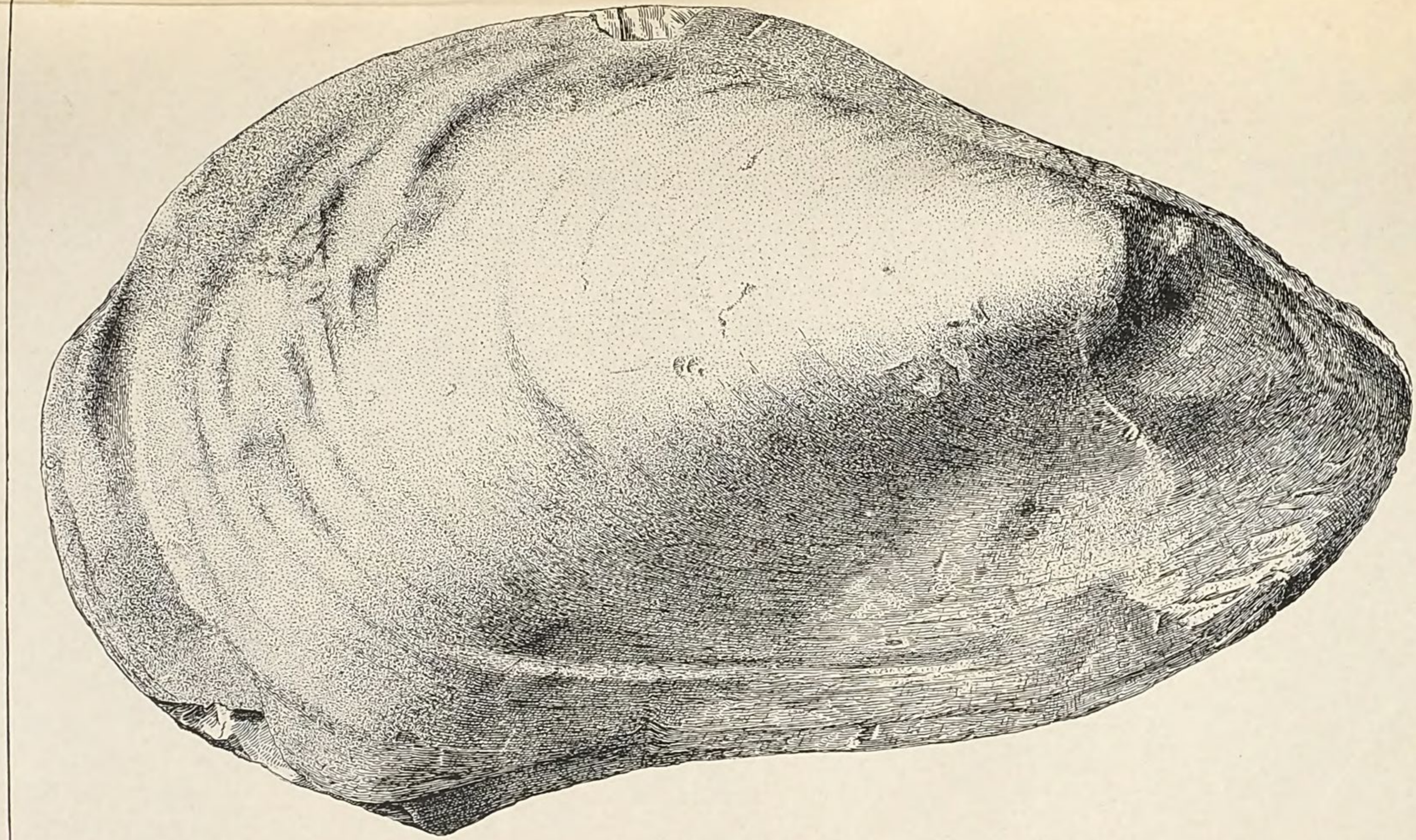
PELECYPODA: OSTREIDÆ, ANOMIIDÆ, SPONDYLIDÆ, LIMIDÆ, PECTINIDÆ, MYTILIDÆ, AND PINNIDÆ.

PLATE III.

PLATE III.

Page.
MODIOLA MAJOR Gabb 48

Fig. 1. An unusually large specimen from the Horsetown beds. Natural size.



PELECYPODA: MYTILIDÆ.

PLATE IV.

PLATE IV.

Page.

AVICULA (OXYTOMA) WHITEAVESI n. sp..... 38

Fig. 1. Left valve.

AUCELLA PIOCHII Gabb..... 42

Figs. 2, 3. Two views of an average-sized left valve like the original type of the species.

Figs. 4, 5. Similar left valves somewhat distorted by pressure.

Figs. 6, 7. Opposite views of a slender, more coarsely plicate specimen.

Fig. 8. Right valve of the typical variety.

Fig. 9. Large left valve with radiating striæ (after White). The striæ are somewhat exaggerated.

Fig. 10. Small right valve with unusually long hinge line associated with the typical variety.

AUCELLA PIOCHII var. OVATA n. var..... 43

Figs. 11–13. Three views of an average specimen.

Fig. 14. A large left valve, provisionally referred to this variety.

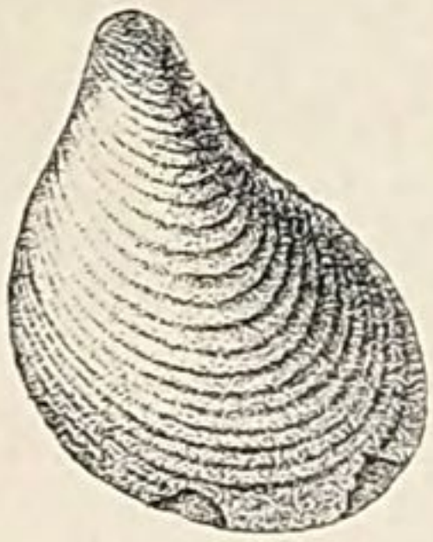
INOCERAMUS OVATUS n. sp..... 47

Fig. 15. A fragmentary right valve.

All figures natural size.



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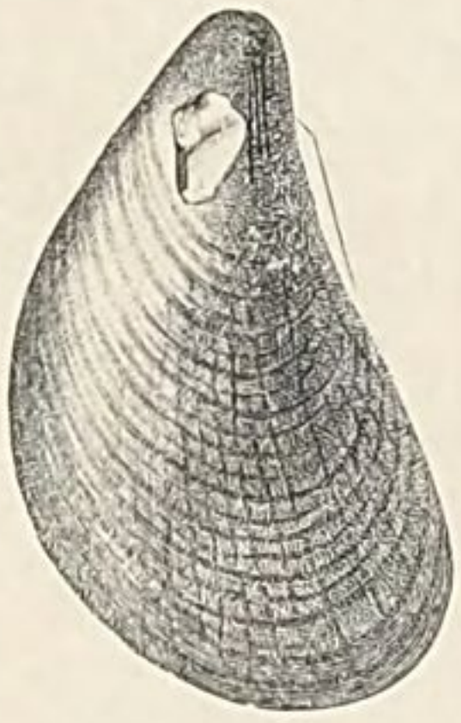
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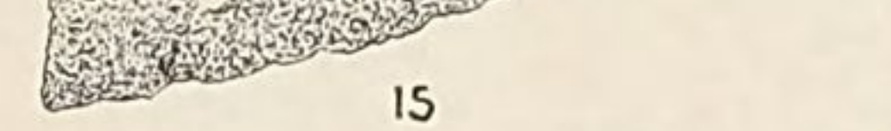
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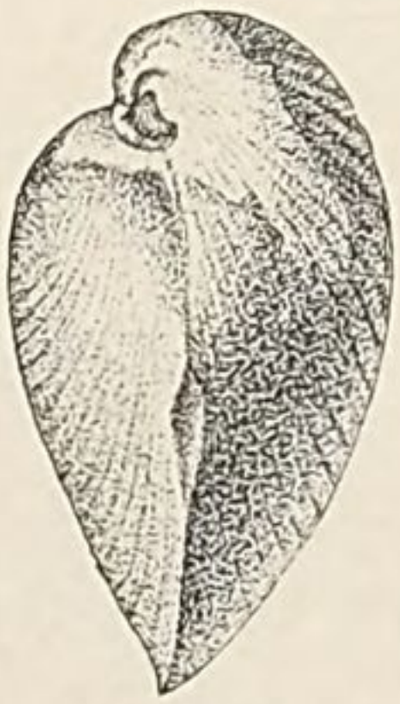
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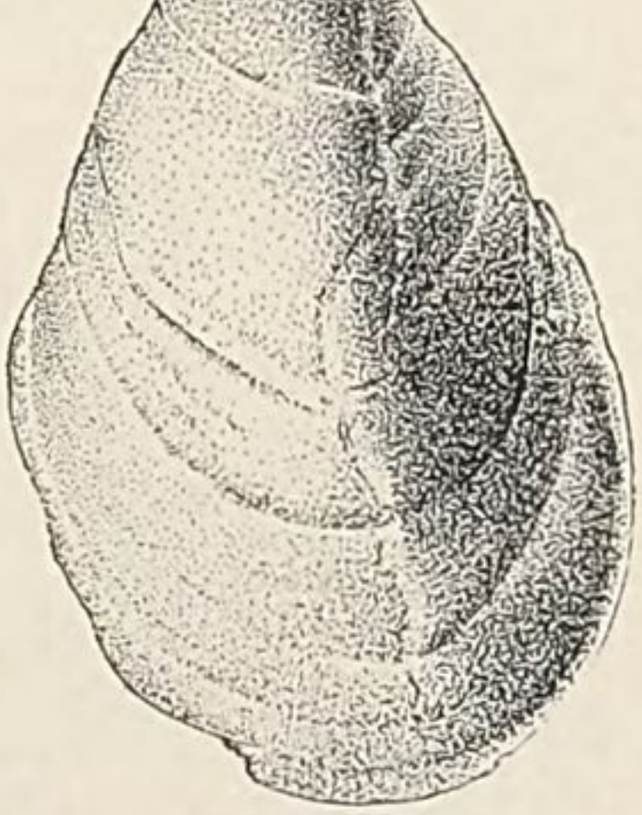
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PELECYPODA: AVICULIDÆ.

PLATE V.

PLATE V.

Page

AUCELLA CRASSICOLLIS Keyserling..... 45

Figs. 1, 2. Profile and hinge views of a right valve, retaining part of the shell.

Figs. 3, 4. Profile and side views of a large right valve.

Figs. 5, 6. Two views of a small specimen from a lower horizon associated with *A. piochii* var. *ovata*.

Fig. 7. Hinge of left valve.

Fig. 8. A small, slender left valve.

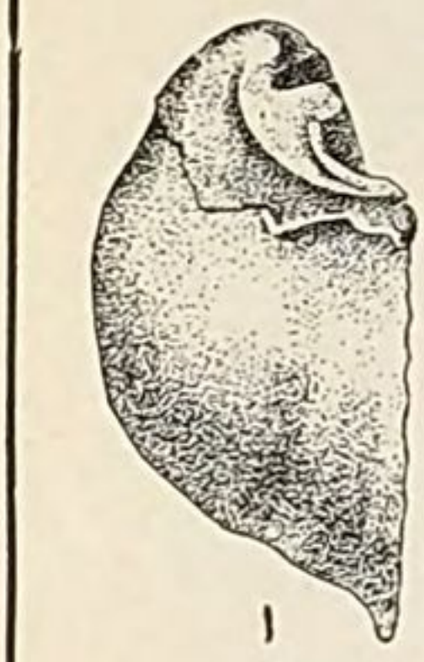
Fig. 9. A large left valve.

Figs. 10, 11. Two views of a left valve resembling *A. crassicollis* var. *gracilis*.

Figs. 12, 13. Right and profile views of a specimen that approaches *A. piochii* var. *ovata* in form.

(*See* additional illustrations of this species on Pl. VI.)

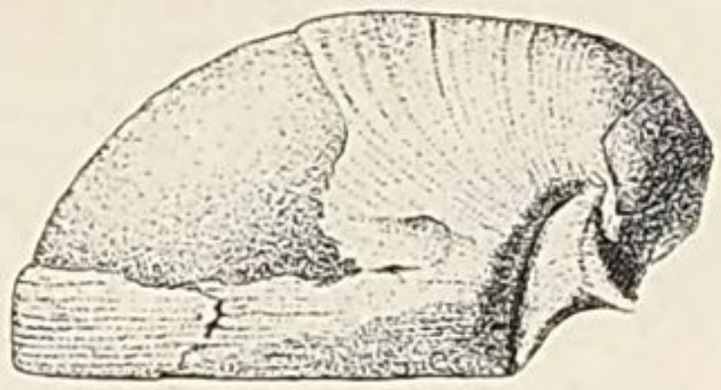
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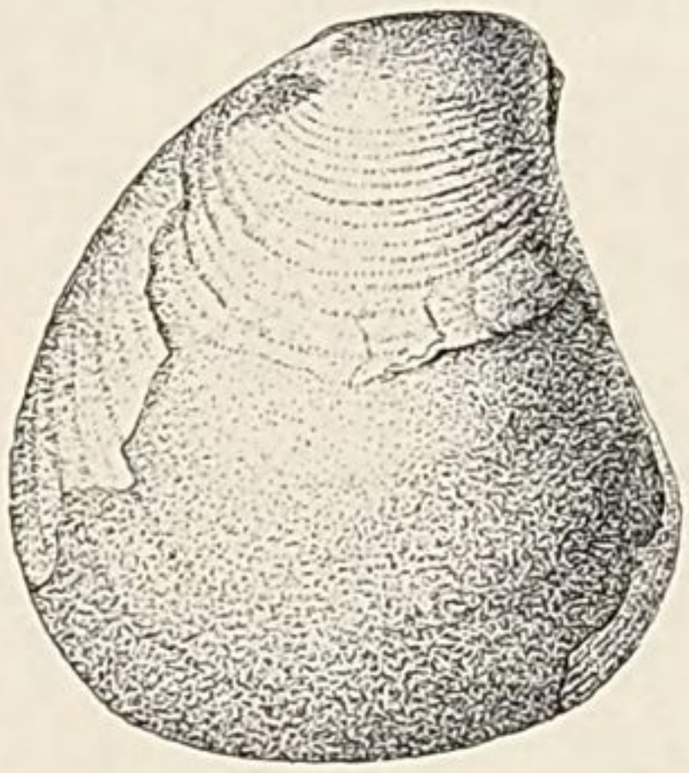
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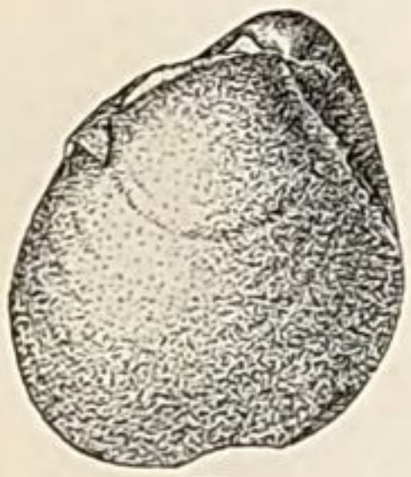
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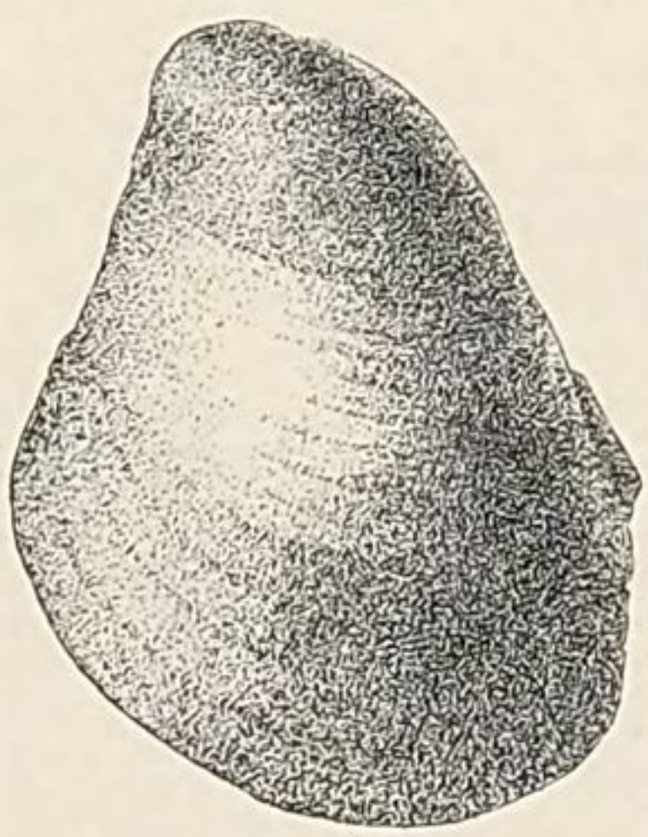
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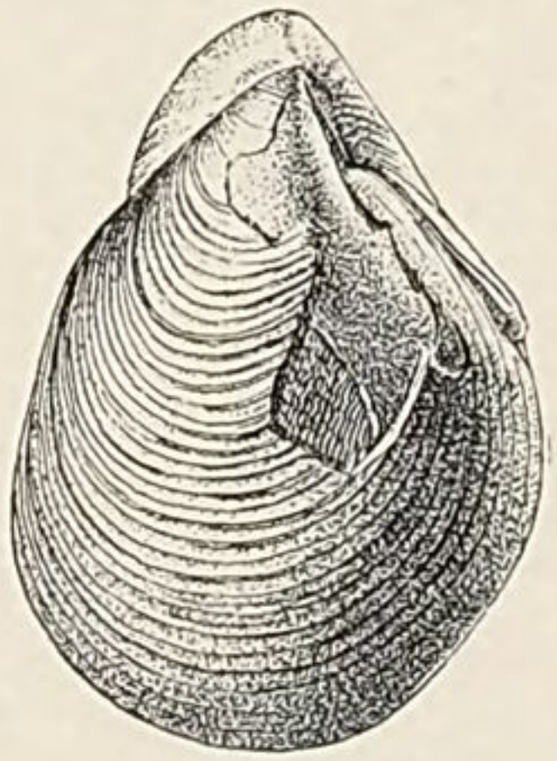
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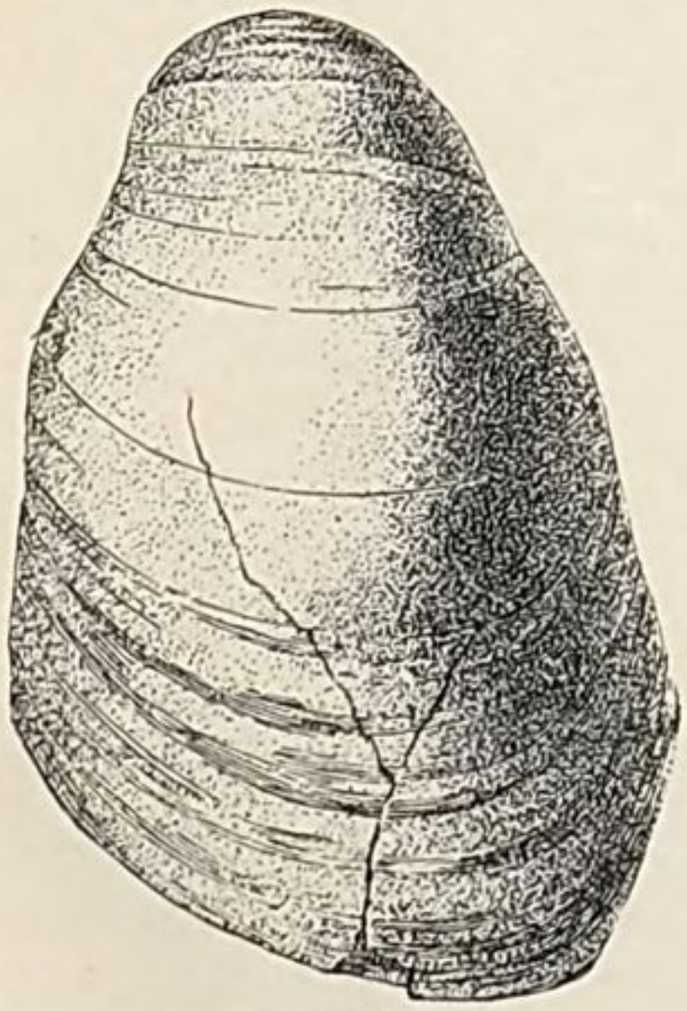
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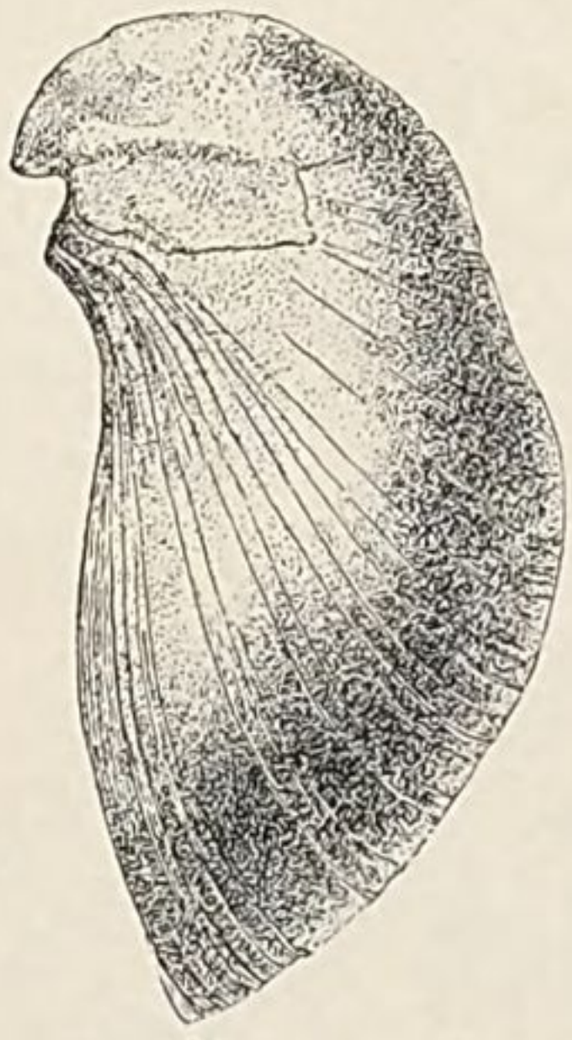
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PELECYPODA: AVICULIDÆ.

PLATE VI.

PLATE VI.

Page.

AUCELLA CRASSICOLLIS Keyserling 45

Fig. 1. Profile view of unusually convex specimen (copy of Gabb's figure of *A. piochii*, Palæont. Cal., Vol. II, pl. 32, fig. 92).

Fig. 2. A very large, robust left valve from the neighborhood of Knoxville (after White).

Figs. 3, 4. Right valve of a strongly plicate variety.

Fig. 5. A more slender plicate left valve associated with 3 and 4.

ARCA TEXTRINA n. sp 50

Fig. 6. Small left valve, enlarged two diameters.

Fig. 7. Slightly crushed and broken large left valve.

ARCA TEHAMAENSIS n. sp 50

Fig. 8. Gutta-percha cast from natural mold of right valve, enlarged two diameters.

PECTUNCULUS ? OVATUS n. sp 51

Fig. 9. Cast of small left valve.

Fig. 10. Cast of right valve, showing impression of hinge and a small part of the shell.

NUCULA GABBI n. sp 51

Figs. 11, 12. Right and cardinal views of a large specimen.

NUCULA STORRSI n. sp 52

Figs. 13, 14. Right and cardinal views of an average specimen.

LEDA GLABRA n. sp 53

Fig. 15. Right valve, enlarged two diameters.

ASTARTE CORRUGATA n. sp 56

Fig. 16. Right valve, enlarged four diamaters.

ASTARTE TRAPEZOIDALIS n. sp 57

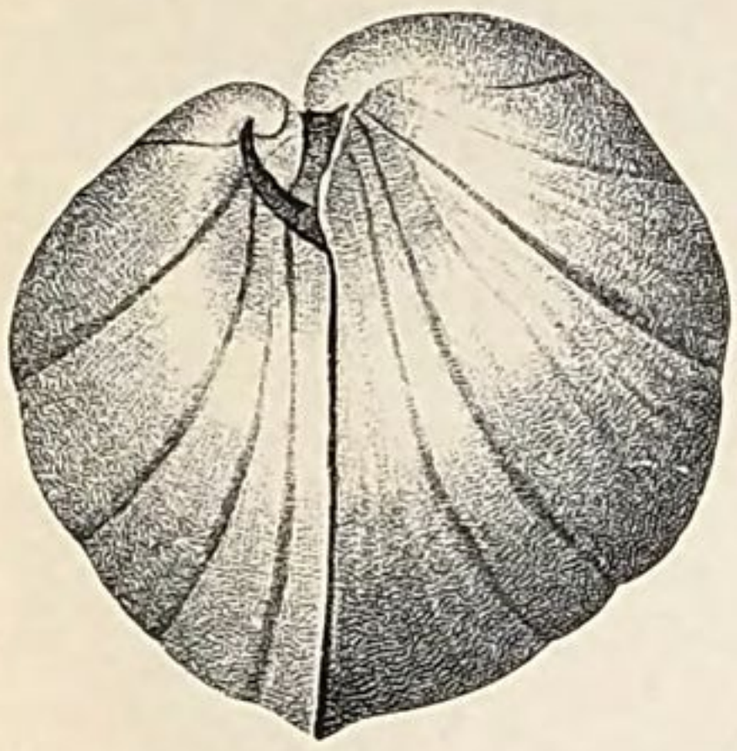
Figs 17, 18. Cardinal and right views of the type.

ASTARTE CALIFORNICA n. sp.

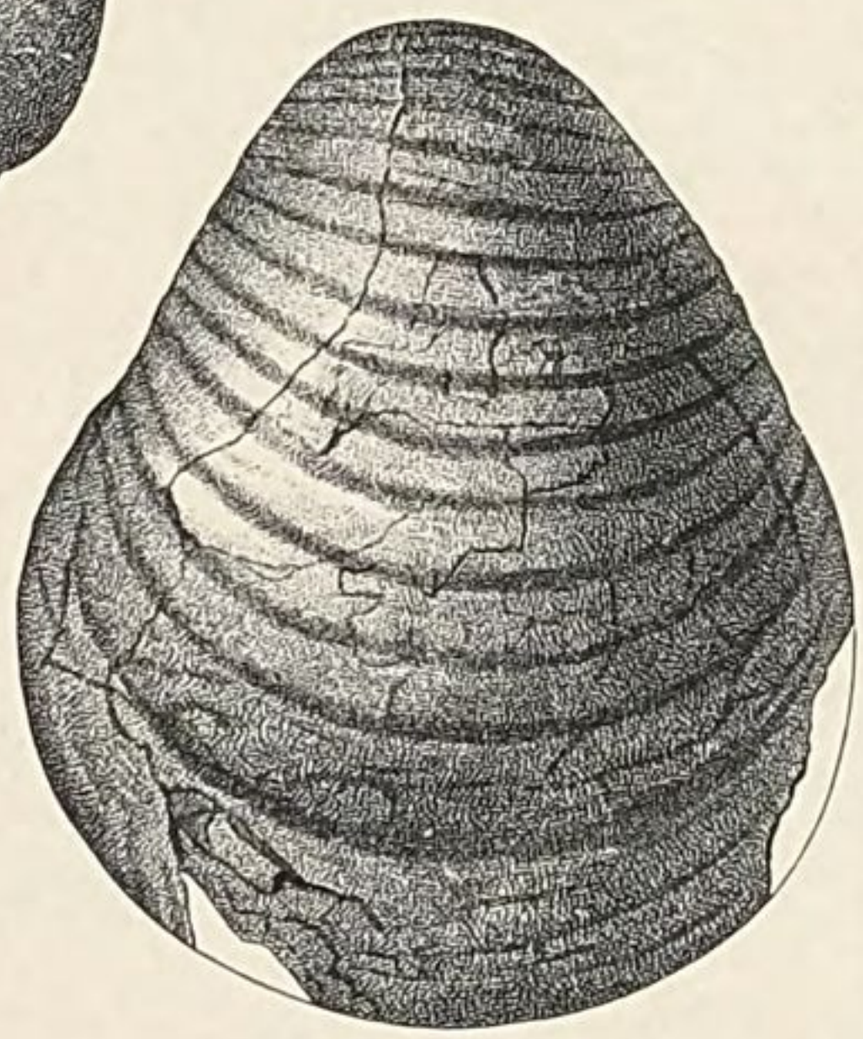
Figs 19, 21. Right valve and hinge of same.

Fig. 20. Left valve (posterior end slightly restored).

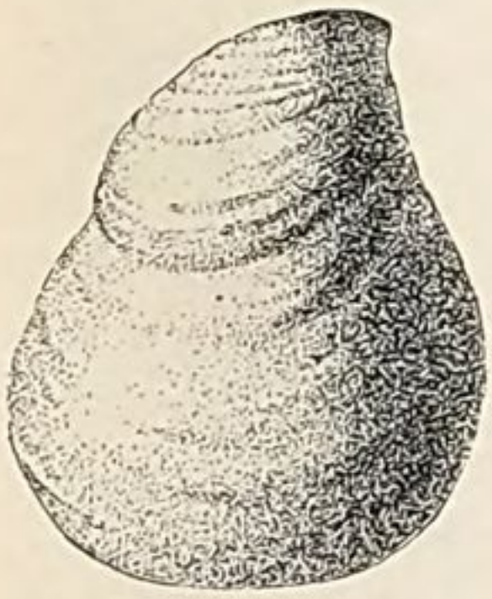
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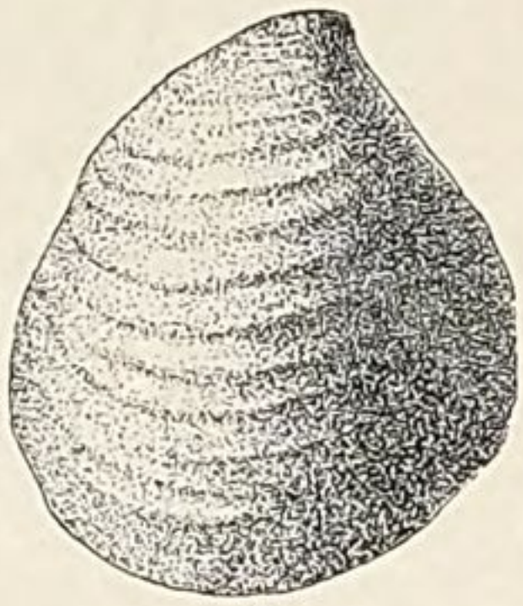
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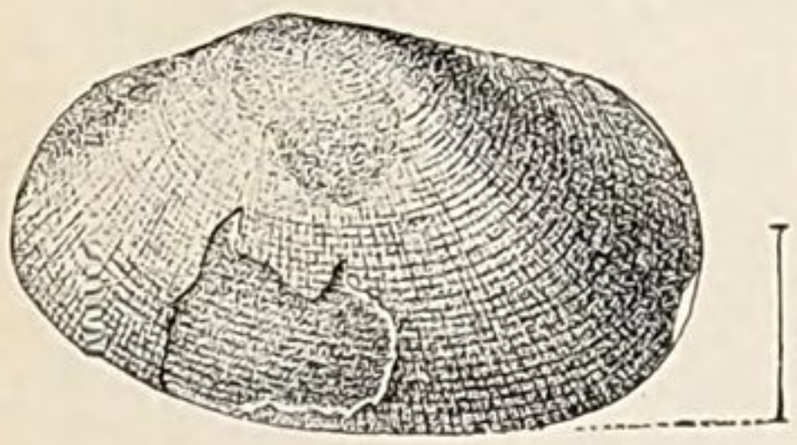
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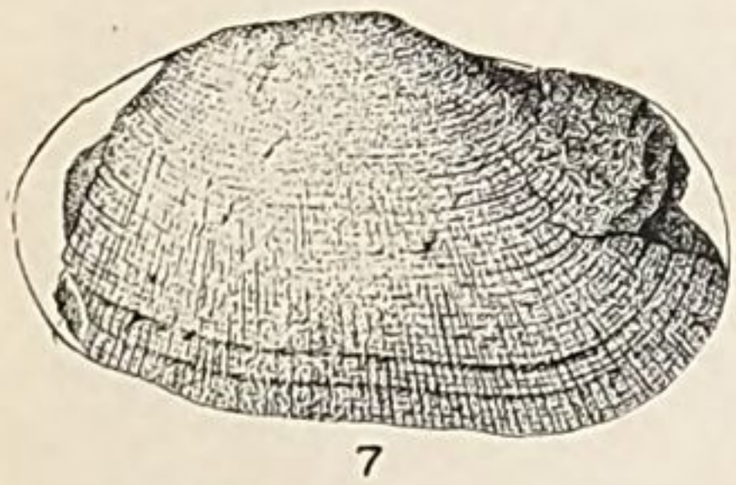
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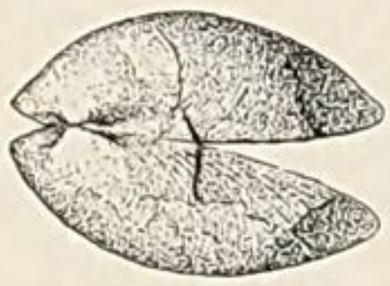
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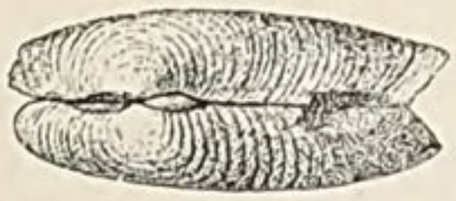
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PELECYPODA: AVICULIDÆ, ARCIDÆ, NUCULIDÆ, AND ASTARTIDÆ.

PLATE VII.

PLATE VII.

Page.

OPIS CALIFORNICA n. sp..... 55

Figs. 1–3. Three views of a rather slender right valve. (In fig. 3 the shell should have been posed so as to show a little of the posterior slope.)

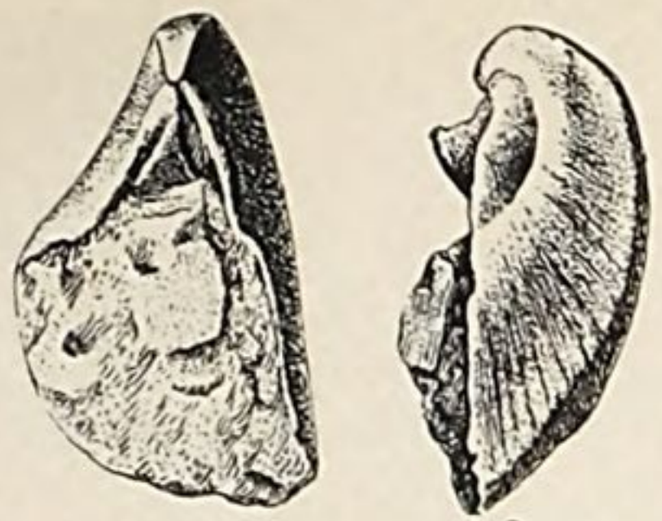
Fig. 4. A broader left valve.

CARDINIOPSIS UNIOIDES n. sp..... 55

Fig. 5. Hinge and interior of left valve, from a wax impression of a natural cast.

(*See* Pls. VIII, IX, and X.)

All figures natural size.



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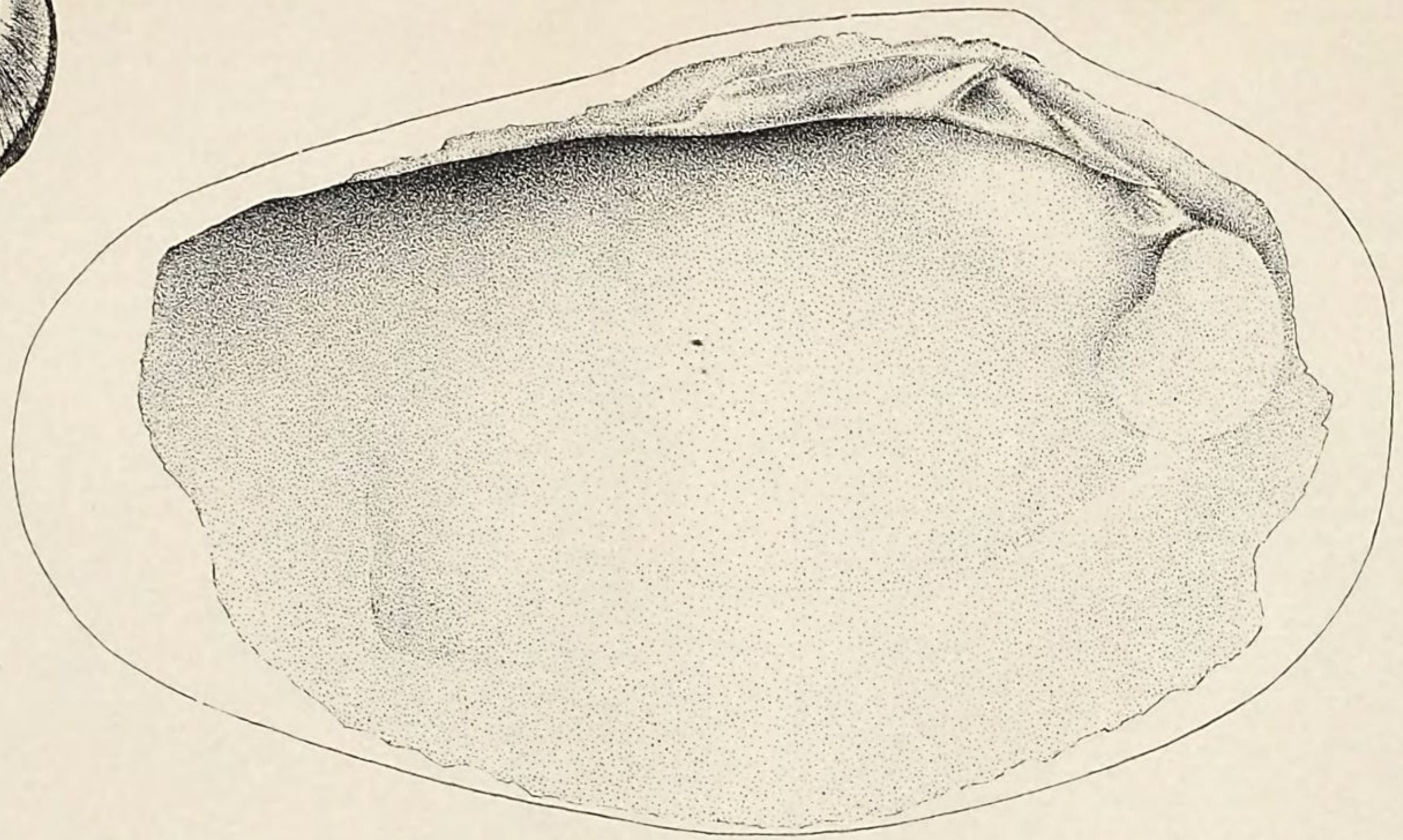
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PELECYPODA: ASTARTIDÆ AND CARDINIIDÆ.

PLATE VIII.

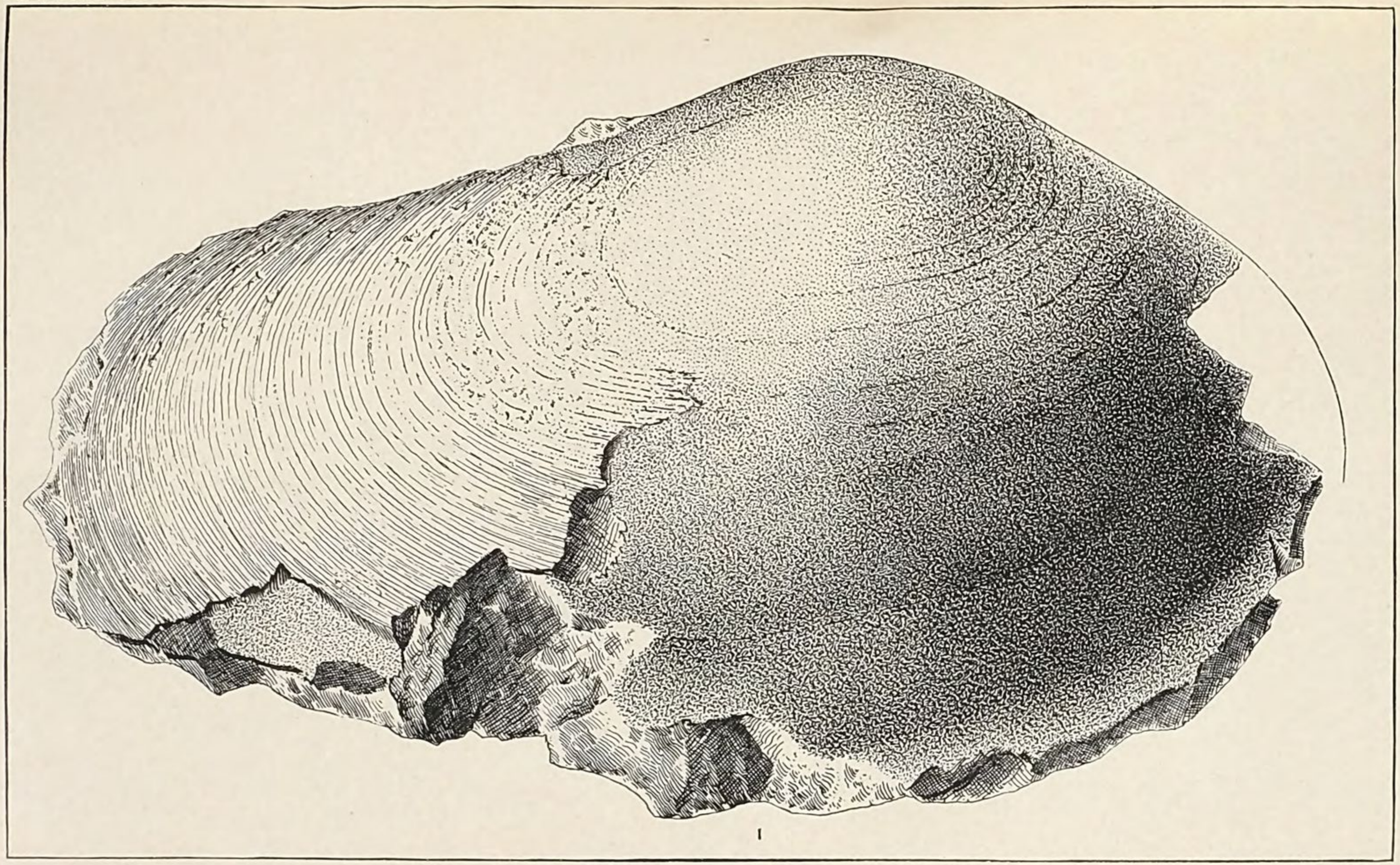
PLATE VIII.

Page

CARDINIOPSIS UNIOIDES n. sp 55

Fig. 1. Right valve of a large specimen. Natural size.

(*See* Pls. VII, IX, and X.)



PELECYPODA: CARDINIIDÆ.

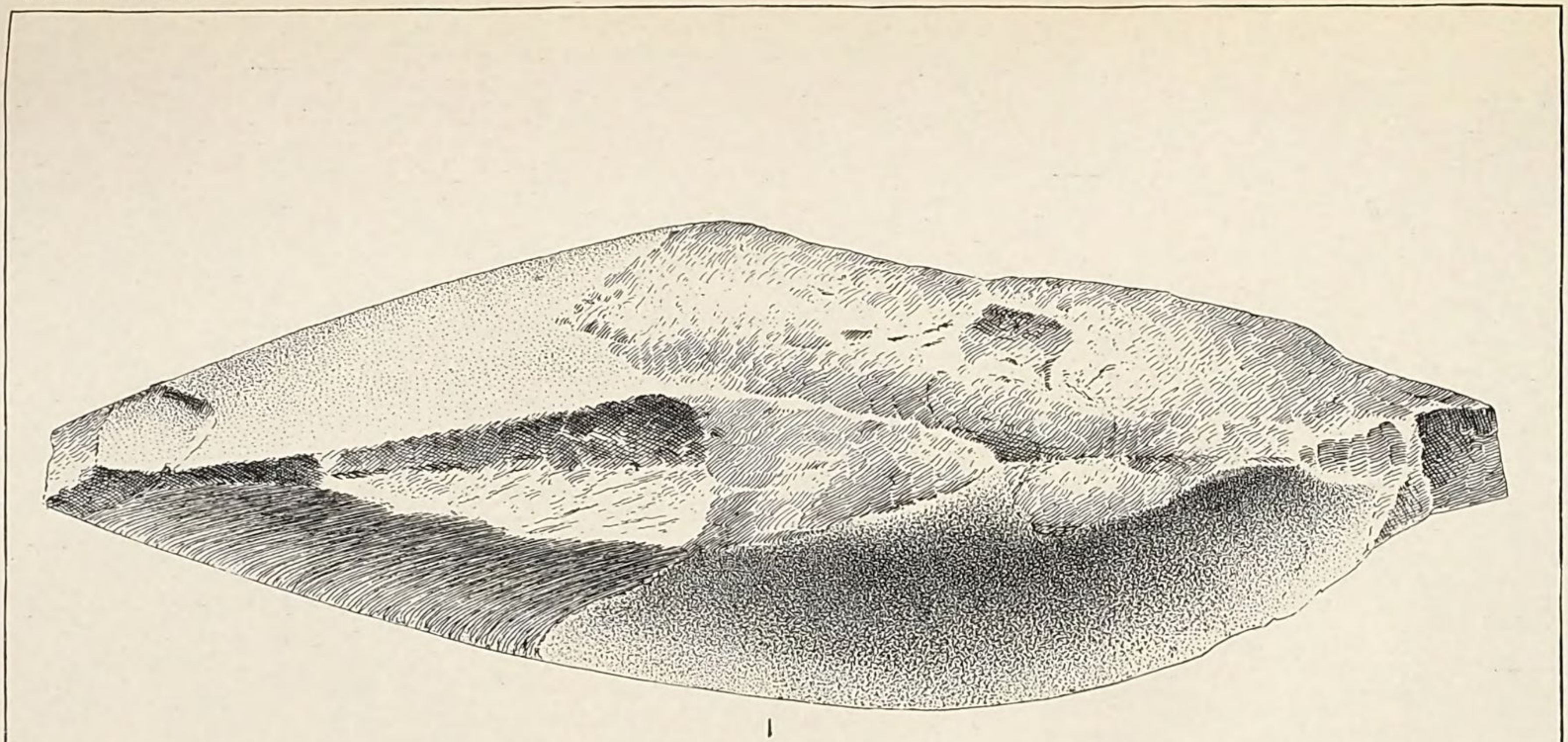
PLATE IX.

PLATE IX.

Page.

CARDINIOPSIS UNIOIDES n. sp 55

Fig. 1. Cardinal view of specimen figured on Pl. VIII. Natural size.
(*See also* Pls. VII and X.)



PELECYPODA: CARDINIIDÆ.

PLATE X.

PLATE X.

Page.

CARDINIOPSIS UNIOIDES n. sp..... 55

Fig. 1. Hinge and muscular impressions of right valve from wax impression of natural cast.

SOLEMYA OCCIDENTALIS n. sp..... 55

Fig. 2. Right view of large internal cast with unusually strong radiating lines.

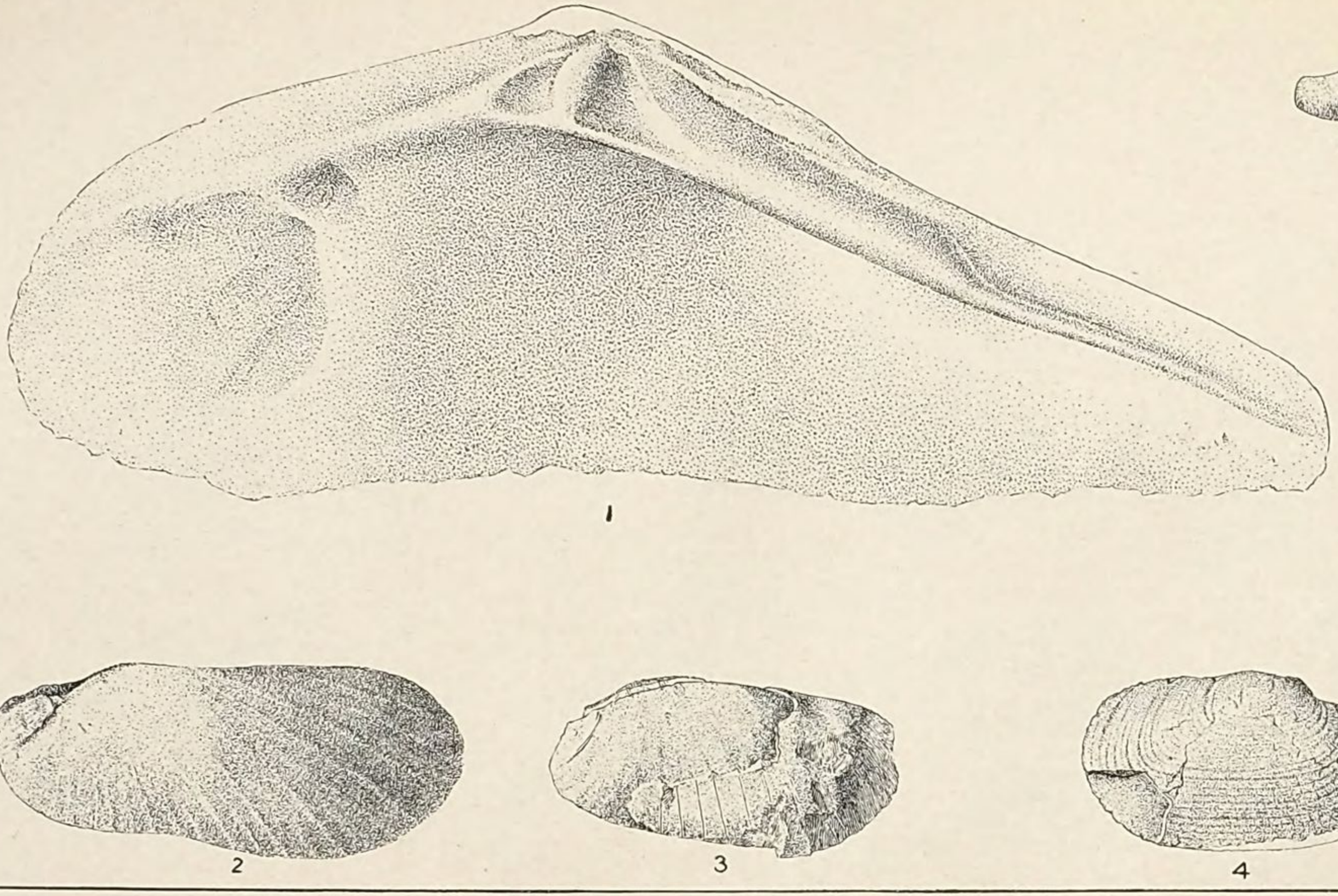
Fig. 3. Smaller right valve, retaining portions of the shell.

SOLECURTUS ? DUBIUS n. sp..... 61

Fig. 4. Right valve.

Fig. 5. Small left valve, supposed to be young of this species.

All figures natural size.



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PELECYPODA: CARDINIIDÆ, SOLEMYIDÆ, AND SOLENIDÆ.

PLATE XI.

PLATE XI.

Page.

CORBULA FILOSA n. sp 62

Fig. 1. Large right valve.

Fig. 2. Small right valve, slightly distorted.

CORBULA ? PERSULCATA n. sp 61

Fig. 3. Left valve with broken posterior end, enlarged two diameters.

LUCINA COLUSAENSIS n. sp 60

Fig. 4. Right valve of type, from Wilbur Springs.

Fig 5. Left valve of a larger imperfect specimen.

ATRESIUS LIRATUS Gabb 68

Fig. 6. A large specimen, supposed to belong to this species, enlarged two diameters. The first two whorls are restored from impressions in the matrix.

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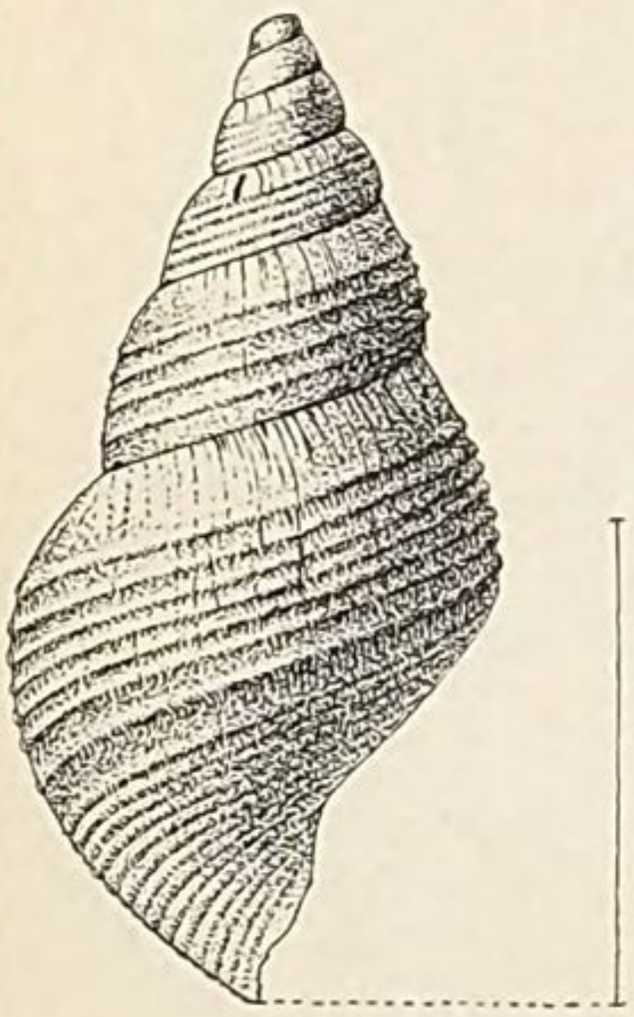
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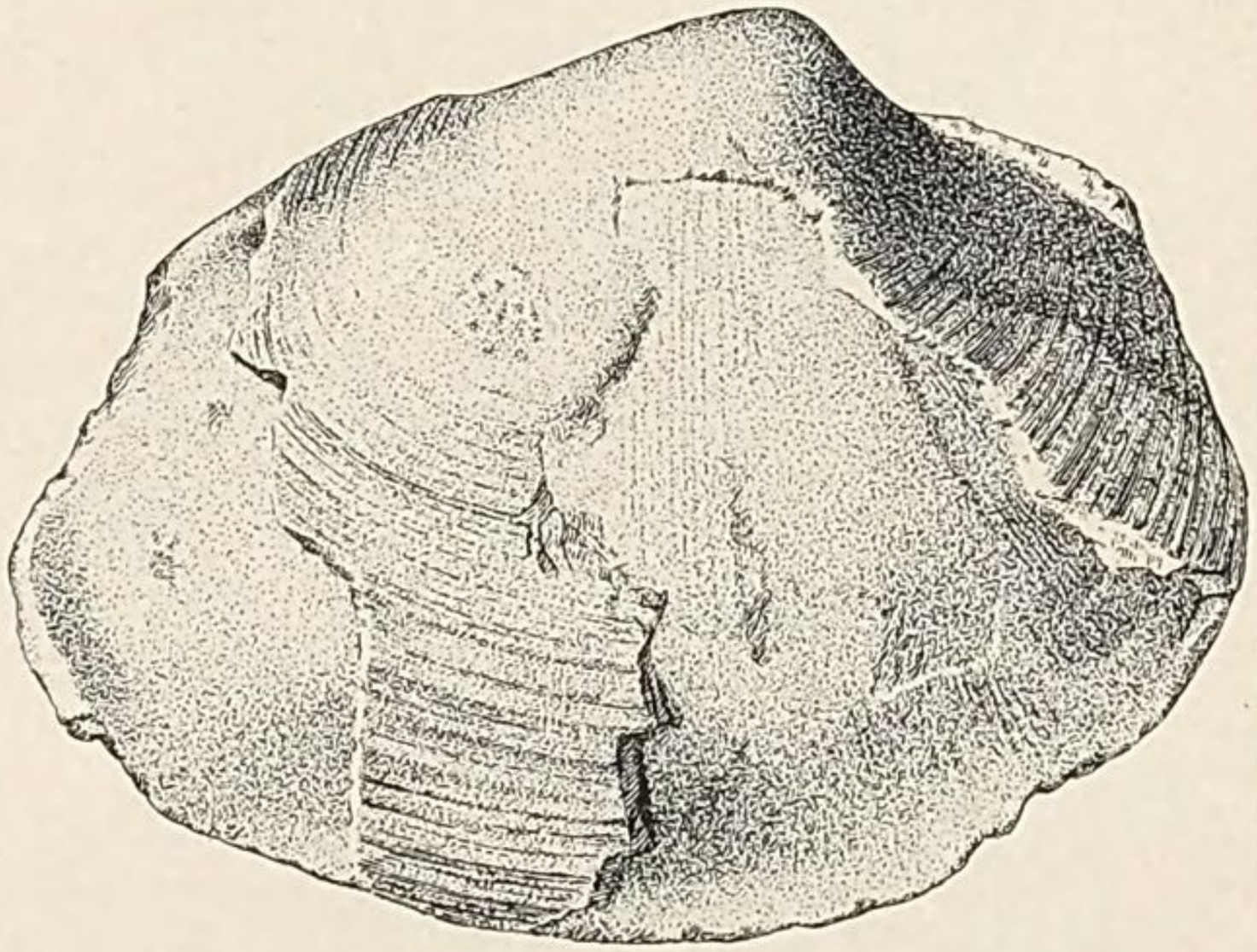
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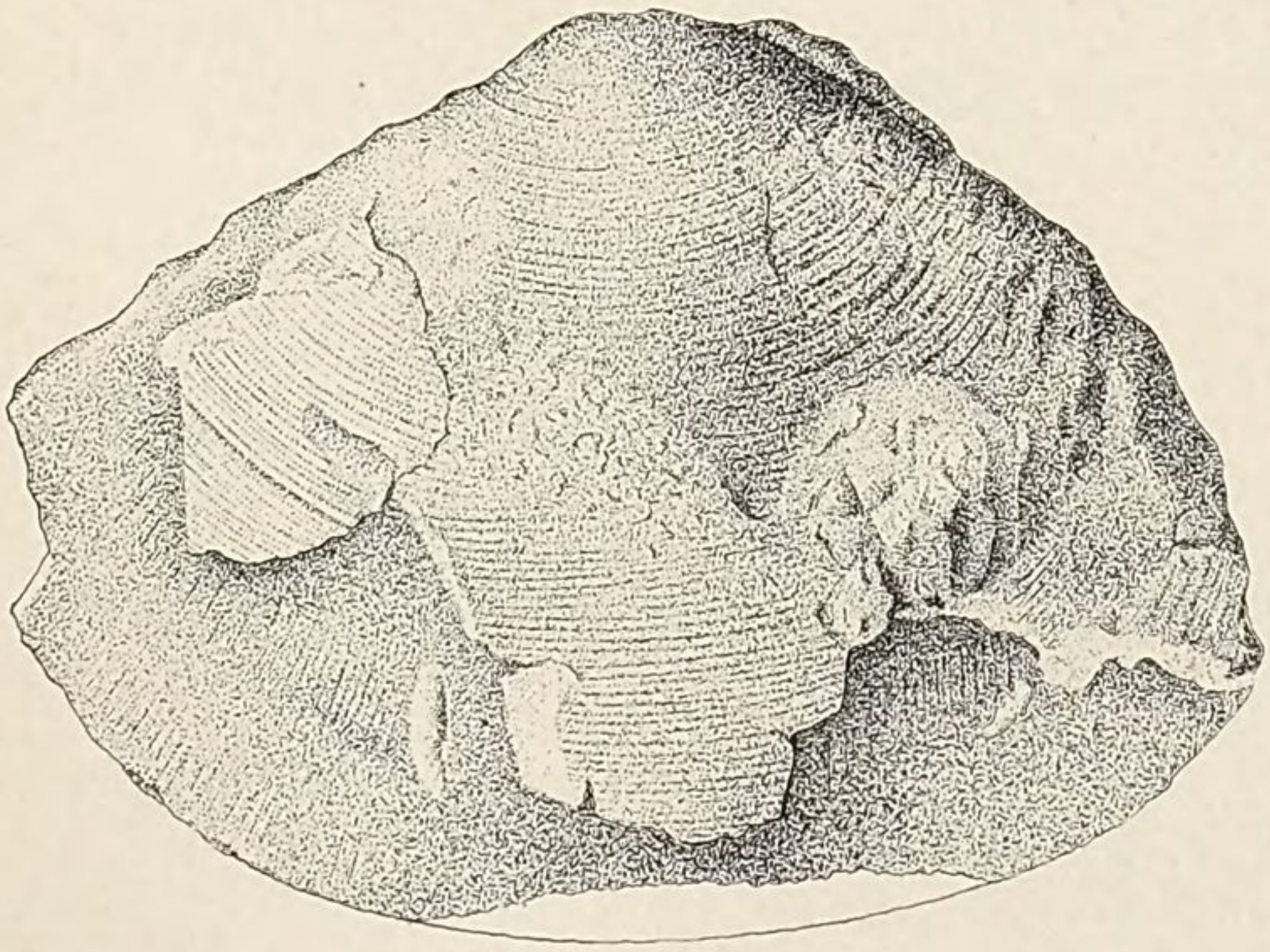
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PELECYPODA AND GASTEROPODA: MYIDÆ, LUCINIDÆ, AND TURBINIDÆ.

PLATE XII.

PLATE XII.

Page.

LUCINA OVALIS n. sp 59

Fig. 1. Left valve of a large specimen.

CYPRINA OCCIDENTALIS Whiteaves 60

Fig. 2. Right valve (anterior end slightly restored).

DENTALIUM CALIFORNICUM n. sp 62

Fig. 3. Medium-sized specimen, enlarged three diameters.

HELCION GRANULATUS n. sp 63

Fig. 4. Small specimen, enlarged two diameters.

TURBO PASKENTAENSIS n. sp 64

Fig. 5. Cast of medium-sized specimen.

Fig. 6. Small, more slender specimen, retaining portions of the shell, enlarged two diameters.

AMBERLEYA DILLERI n. sp 68

Fig. 7. Small, slender specimen, from gutta-percha cast of natural mold, enlarged two diameters.

Fig. 8. Similar cast of a larger, less elevated specimen.

Fig. 9. Aperture view of an average-sized specimen lacking the spire.

TURBO HUMEROSUS n. sp 67

Fig. 10. Small, slender specimen, enlarged two diameters.

Fig. 11. A less elevated specimen, showing differences in sculpture, enlarged two diameters.

TURBO TRILINEATUS n. sp 65

Fig. 12. Type specimen, natural size. The sculpture is somewhat exaggerated.

TURBO MORGANENSIS n. sp 66

Fig. 13. An average-sized specimen, from a gutta-percha cast of a natural mold, enlarged two diameters.

TURBO COLUSAENSIS n. sp 66

Fig. 14. Aperture view of a cast.

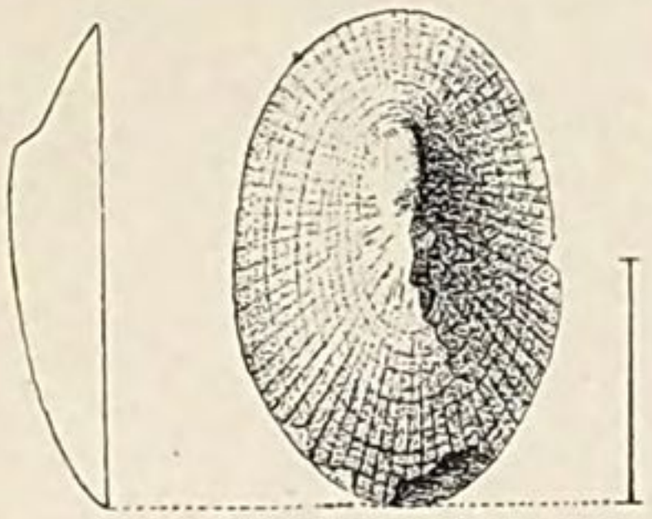
TURBO WILBURENSIS n. sp 65

Fig. 15. Aperture view of a distorted cast, retaining some of the surface sculpture.

Unless otherwise stated the figures are natural size.



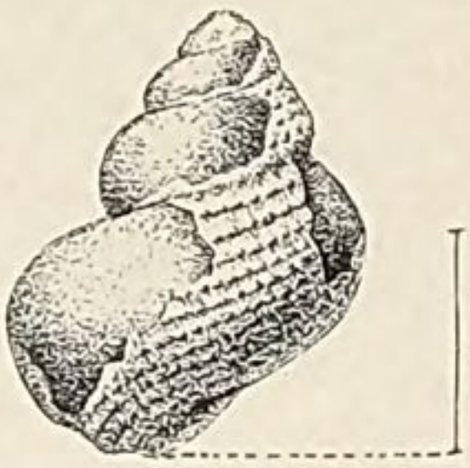
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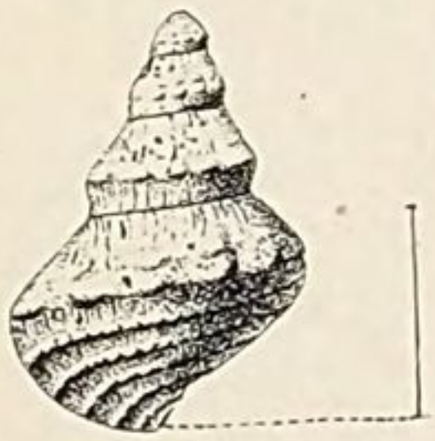
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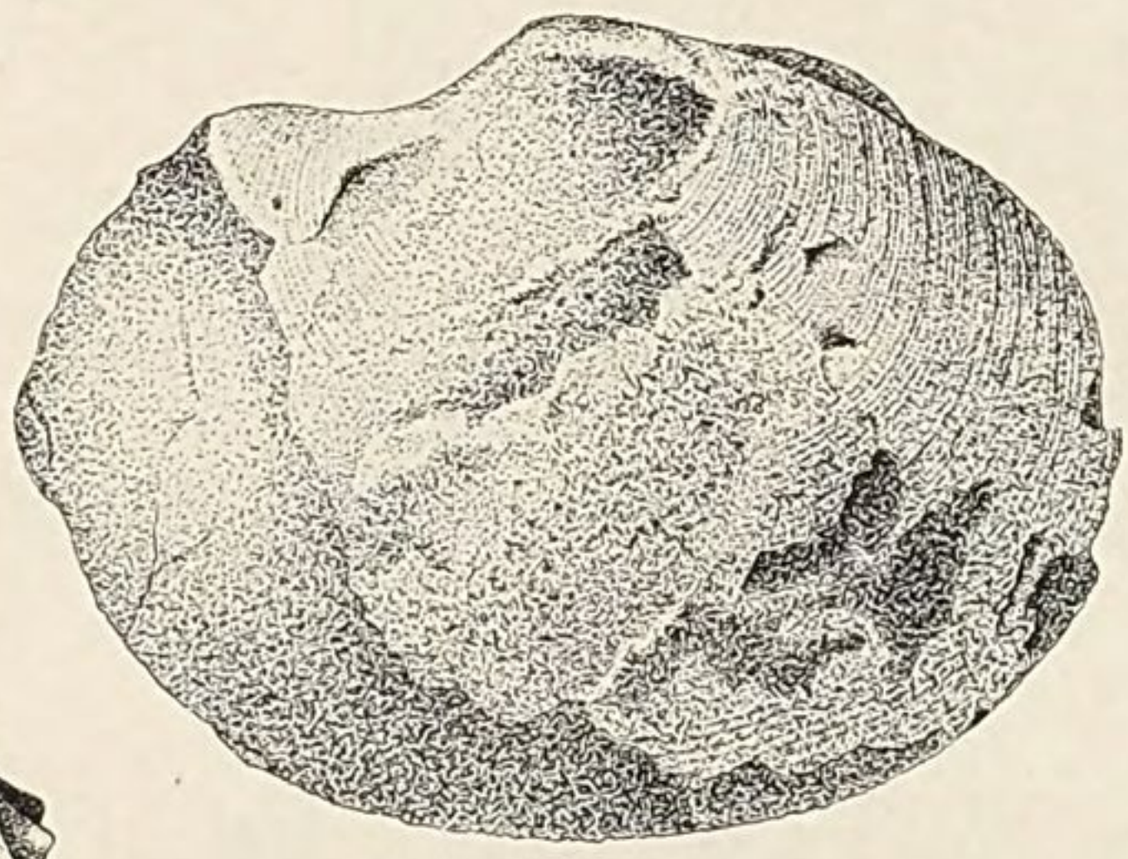
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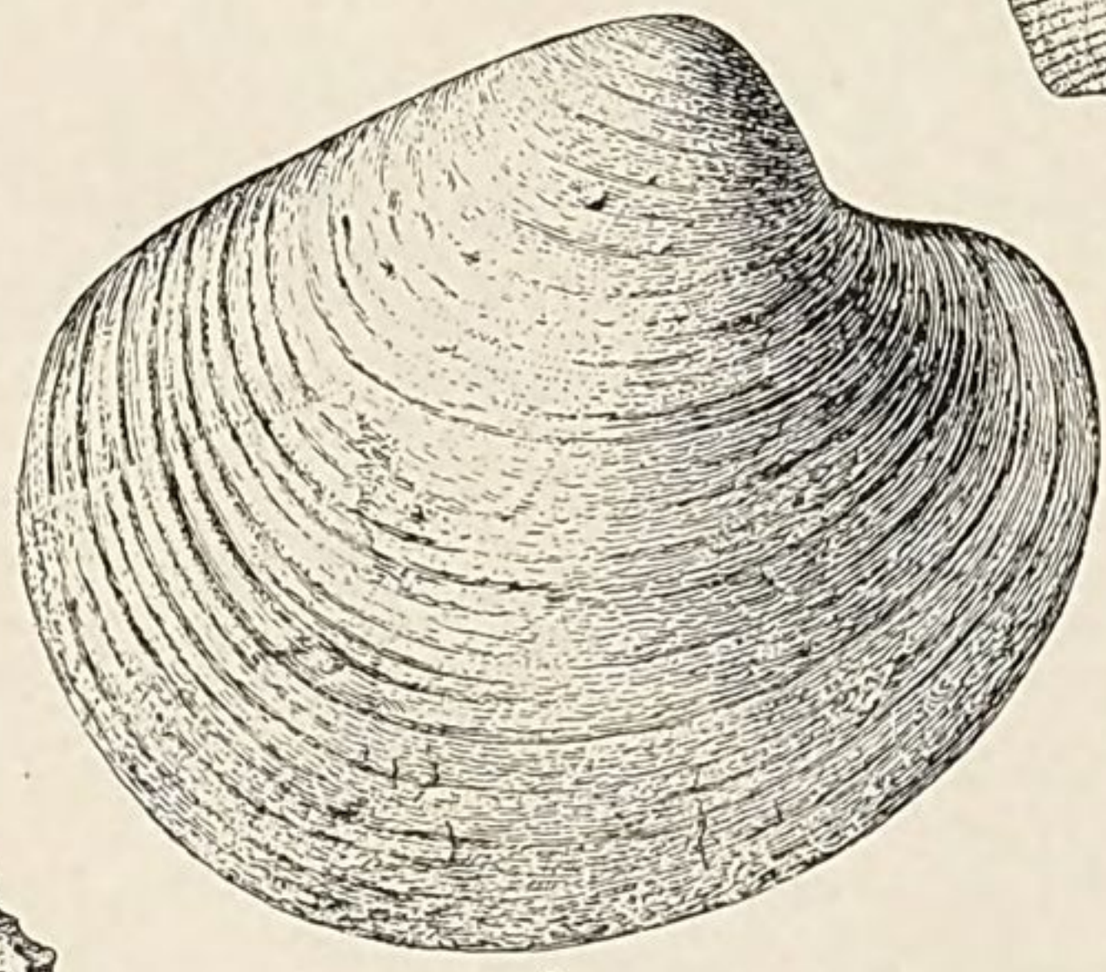
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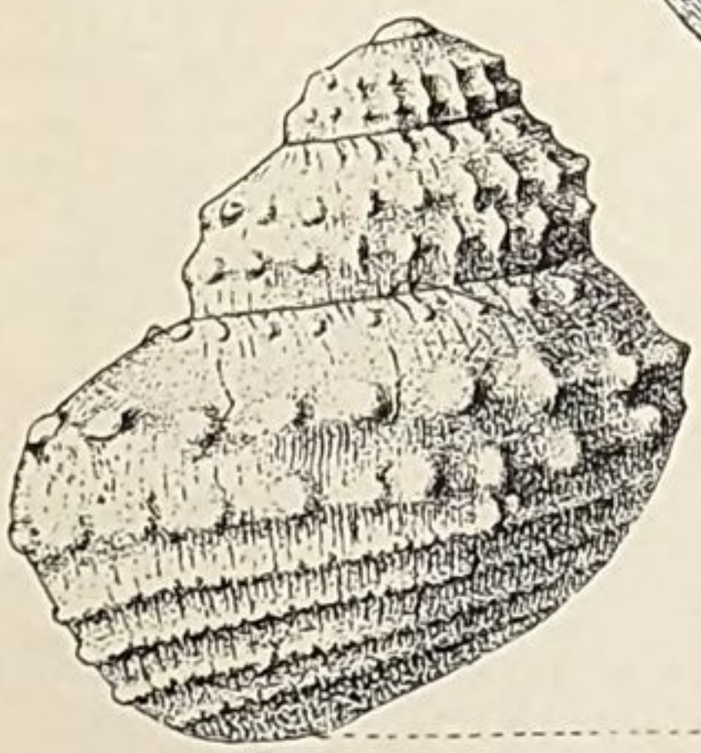
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PELECYPODA AND GASTEROPODA: LUCINIDÆ, CYPRINIDÆ, DENTALIIDÆ, TURBINIDÆ, AND PATELLIDÆ.

PLATE XIII.

PLATE XIII.

Page.

HYPSIPLEURA GREGARIA n. sp 70

Fig. 1. Aperture view of small specimen, enlarged four diameters.

Fig. 2. Dorsal view of larger specimen, enlarged four diameters.

HYPSIPLEURA ? OCCIDENTALIS n. sp 70

Fig. 3. Aperture view of gutta-percha cast of natural mold, enlarged two diameters.

Fig. 4. Dorsal view of larger specimen, similarly enlarged.

CERITHIUM PASKENTAENSIS n. sp 71

Fig. 5. Aperture view of imperfect specimen, enlarged two diameters.

Fig. 6. Dorsal view of internal cast, similarly enlarged.

CERITHIUM STRIGOSUM n. sp 71

Fig. 7. Gutta-percha cast of natural mold, enlarged two diameters.

FISSURELLA BIPUNCTATA n. sp 63

Fig. 8. Type specimen, enlarged two diameters.

LYTOCERAS BATESII Trask 75

Fig. 9. Fragment of a large specimen showing part of the peristome. From Lower Horsetown beds, north of Paskenta.

Fig. 10. Cross section of peristome at lower part of fig. 9.

Fig. 11. A small specimen from the Upper Knoxville beds, on Wilcox's ranch, Tehama County, Cal.

Unless otherwise stated the figures are natural size.



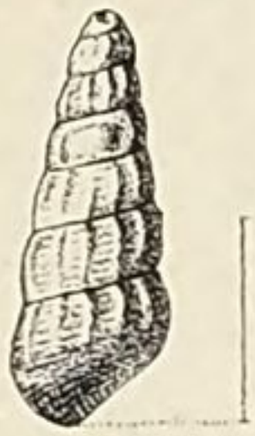
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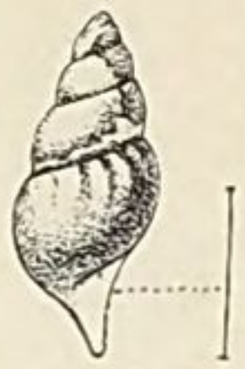
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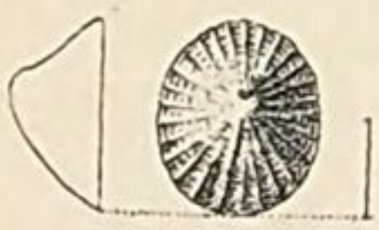
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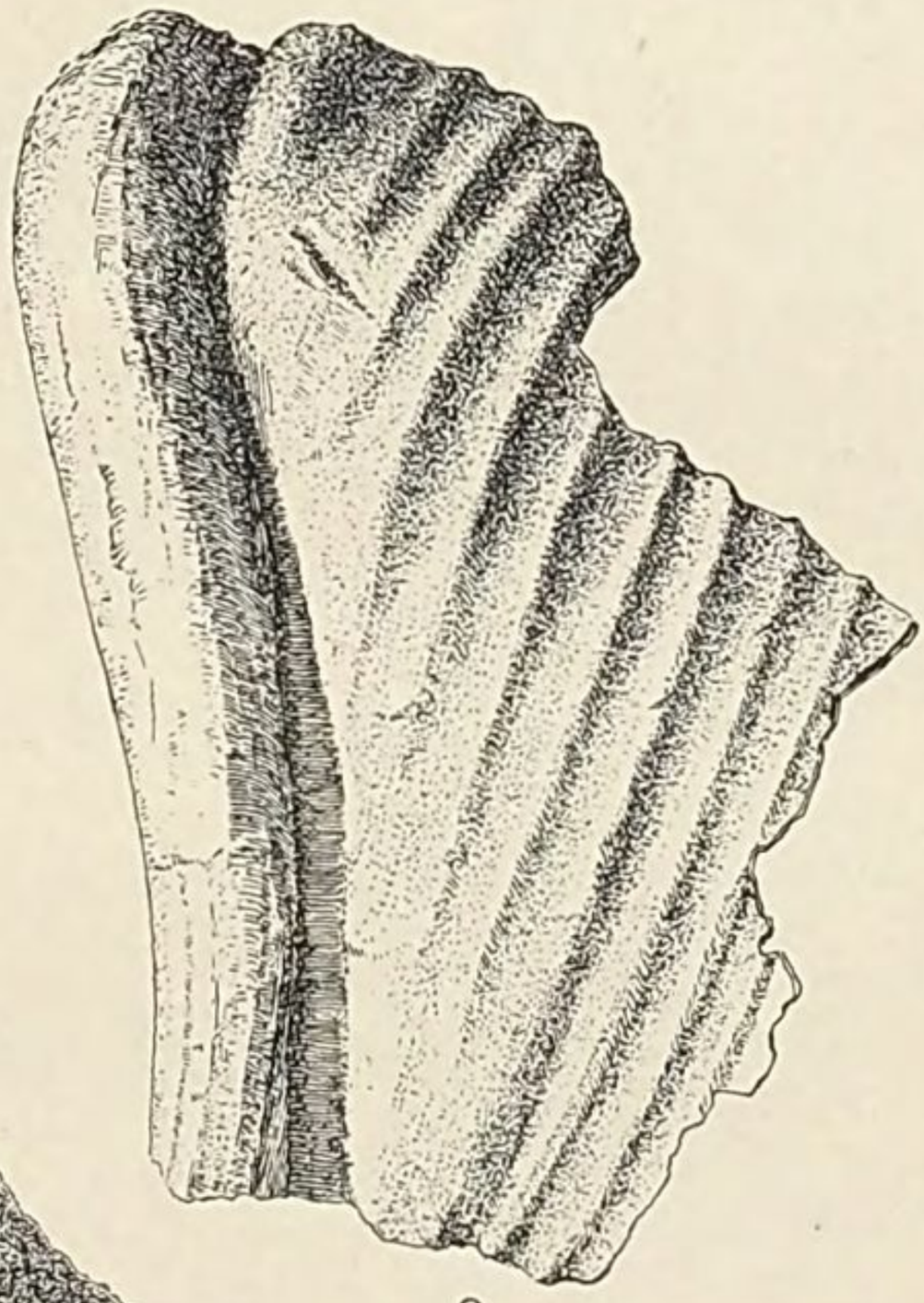
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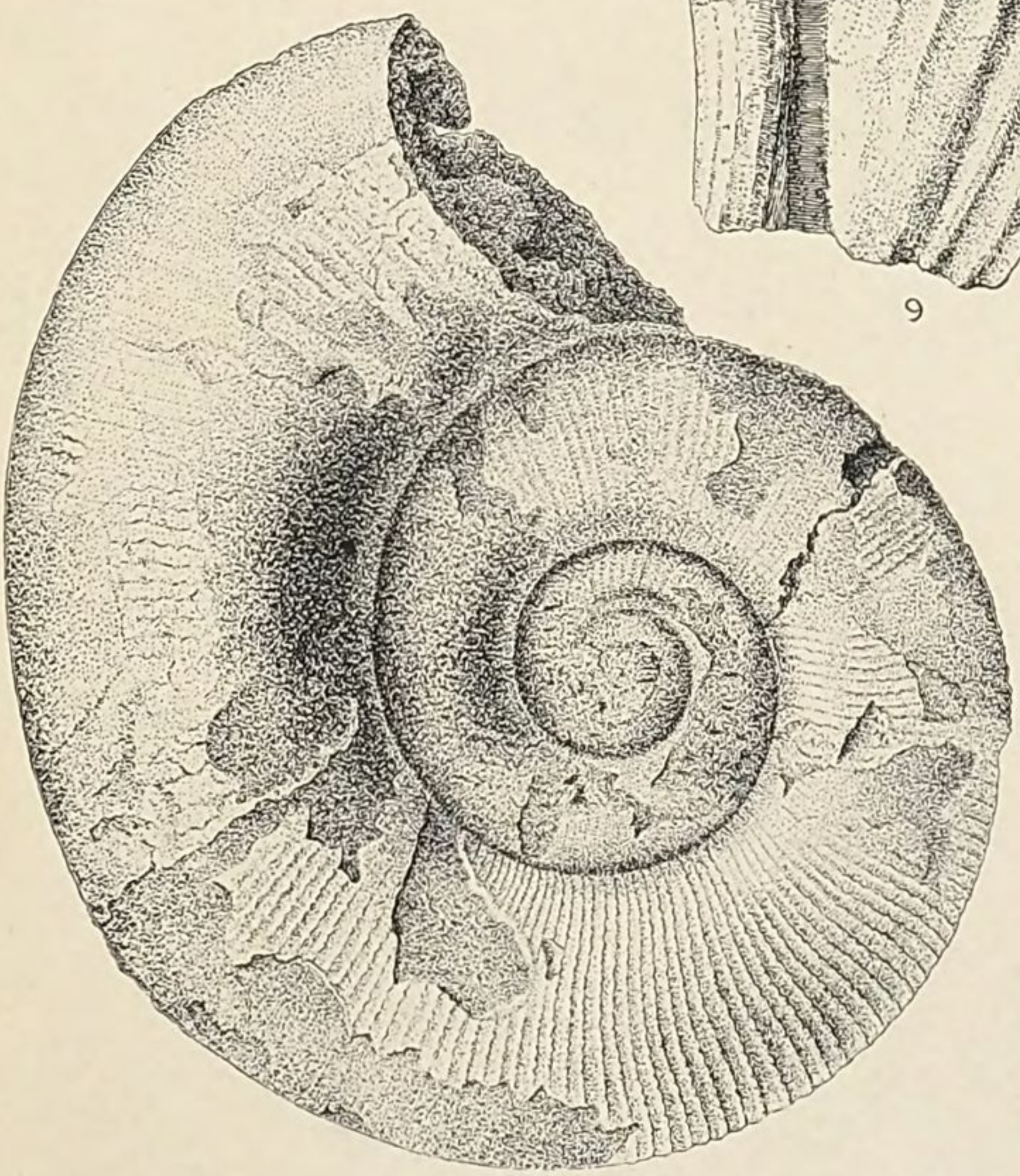
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GASTEROPODA AND CEPHALOPODA: CERITHIIDÆ, FISSURELLIDÆ, PYRAMIDELLIDÆ, AND LYTOCERAS.

PLATE XIV.

PLATE XIV.

Page.

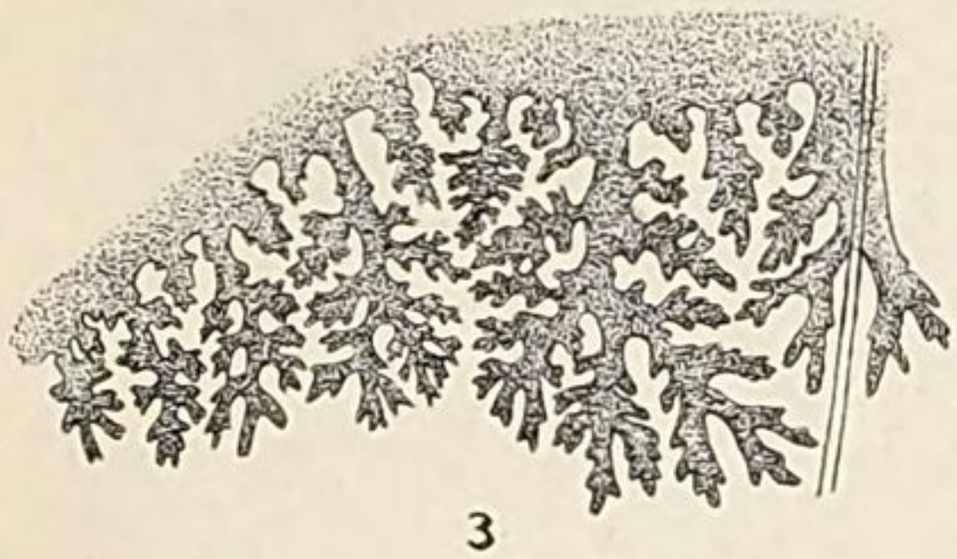
PHYLLOCERAS KNOXVILLENSIS n. sp. 72

Figs. 1, 2. Two views of the type. (The umbilicus is not as large as the hole that has been bored through the specimen.)

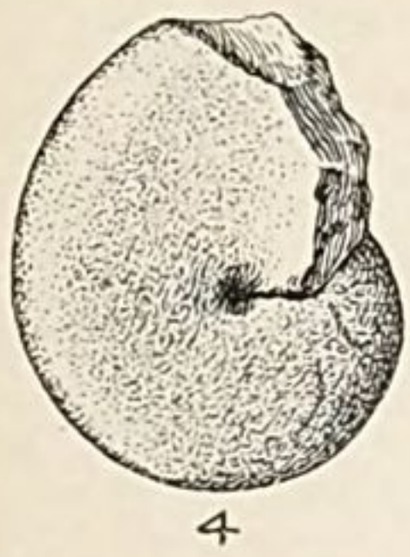
Fig. 3. Septum of same specimen, from a tracing. (The finer divisions of the lobes are too broad and consequently those of the saddles are too narrow.)

Fig. 4. A small specimen provisionally regarded as the young of this species.

All figures natural size.



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CEPHALOPODA: PHYLLOCERAS.

PLATE XV.

PLATE XV.

Page.

OLCOSTEPHANUS MUTABILIS n. sp..... 77

Fig. 1. An average-sized specimen.

Fig. 2. Portion of septum of same specimen enlarged.

Fig. 3. A crushed specimen showing change of sculpture in later stages of growth.

Fig. 4. Ventral view of same specimen.

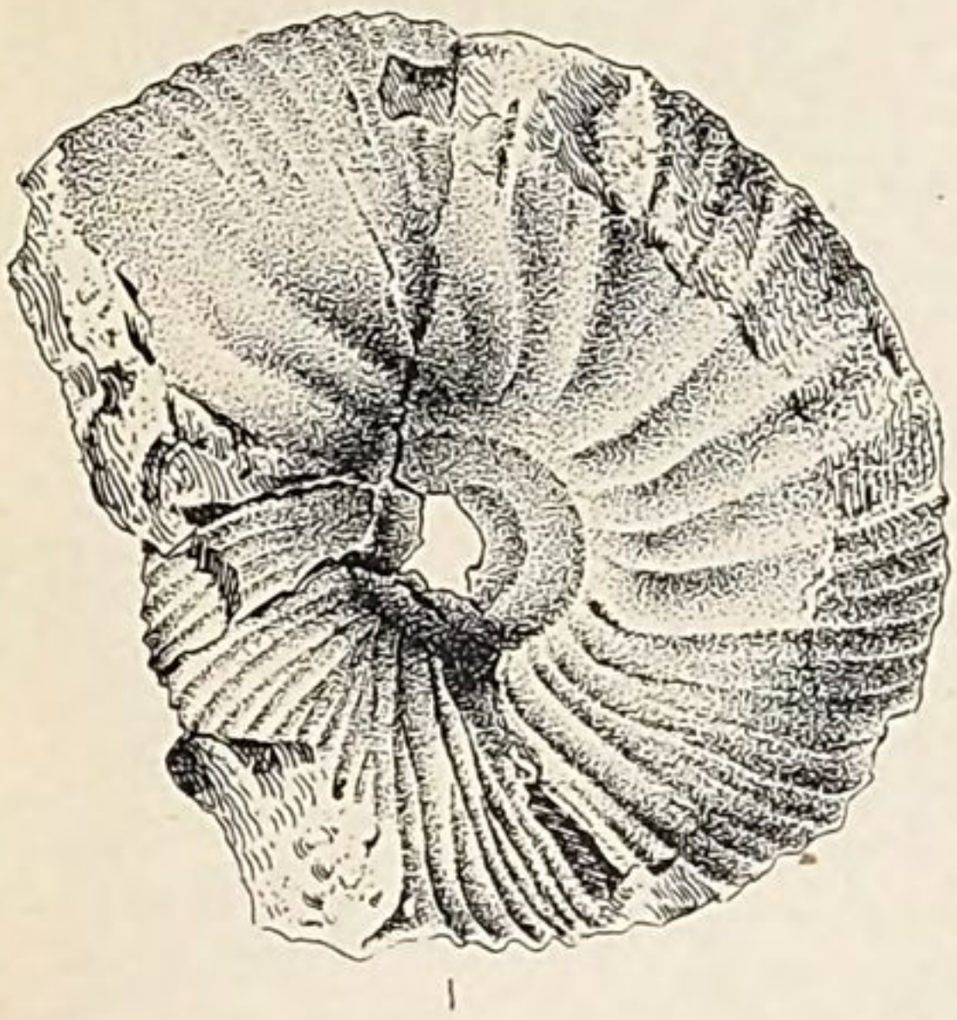
Fig. 5. Small specimen with trifurcate ribs on outer whorl.

DESMOCERAS CALIFORNICUM n. sp..... 76

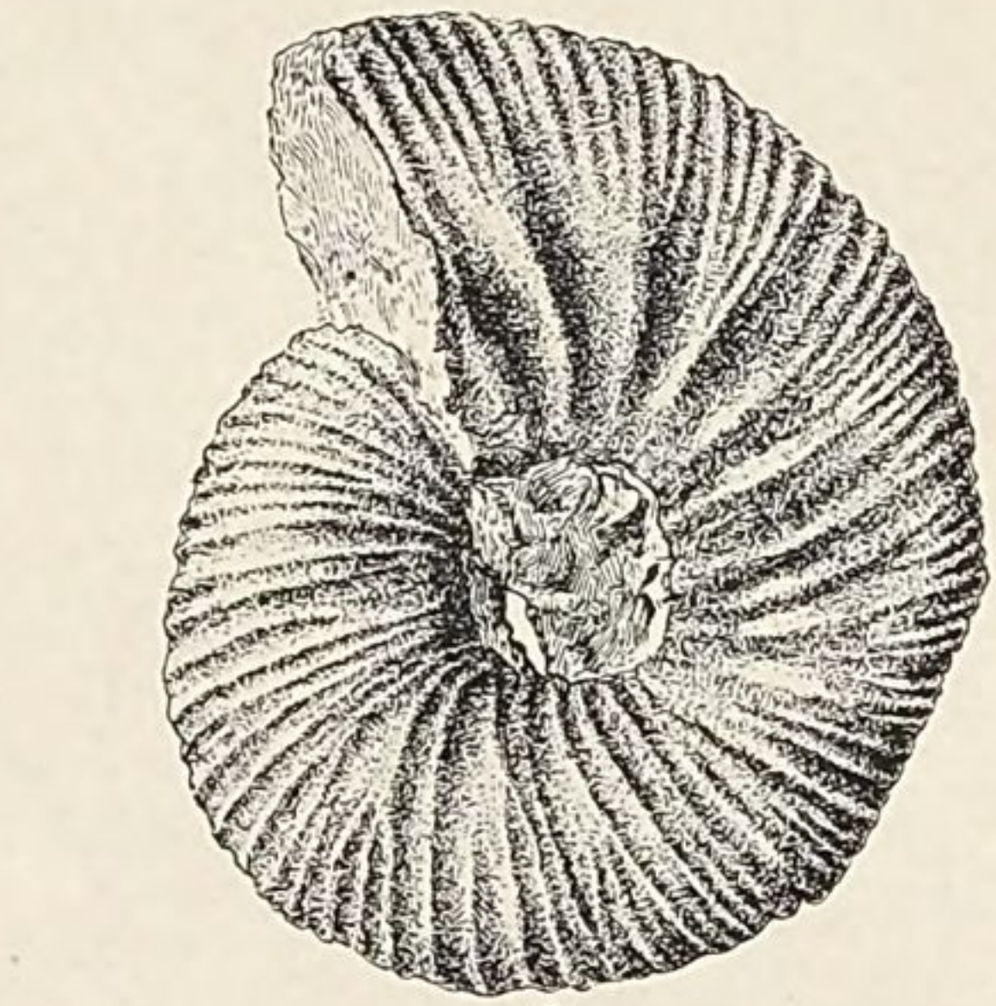
Fig. 6. Fragment of two volutions.

Fig. 7. Septum of another fragment, probably of same individual, from a tracing.

Unless otherwise stated the figures are natural size.



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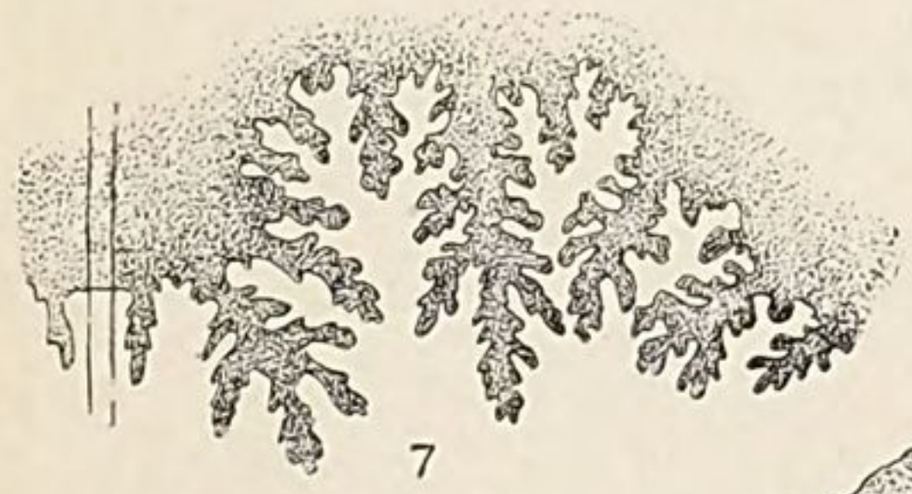
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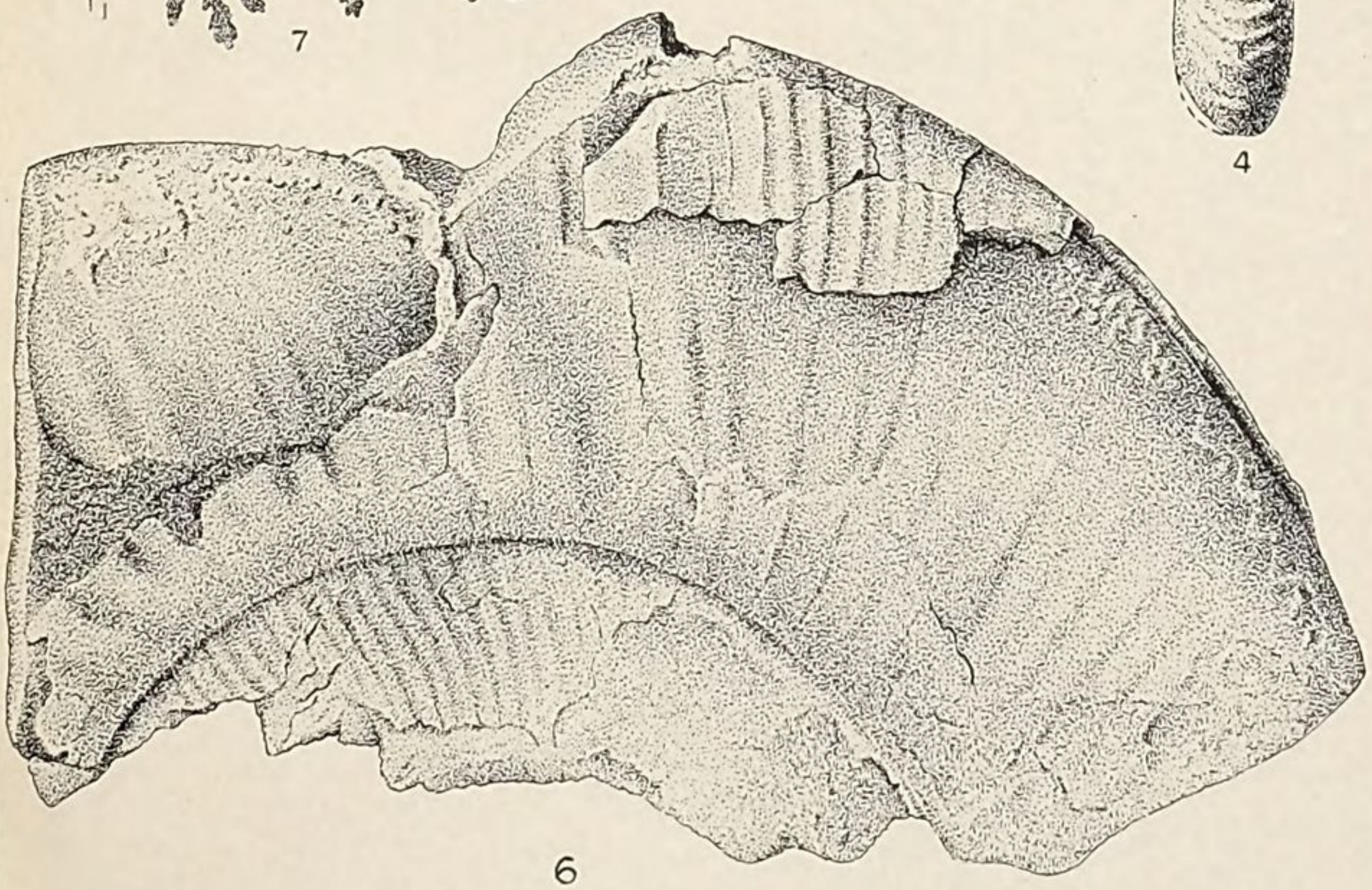
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CEPHALOPODA: OLCOSTEPHANUS AND DESMOCERAS.

PLATE XVI.

PLATE XVI.

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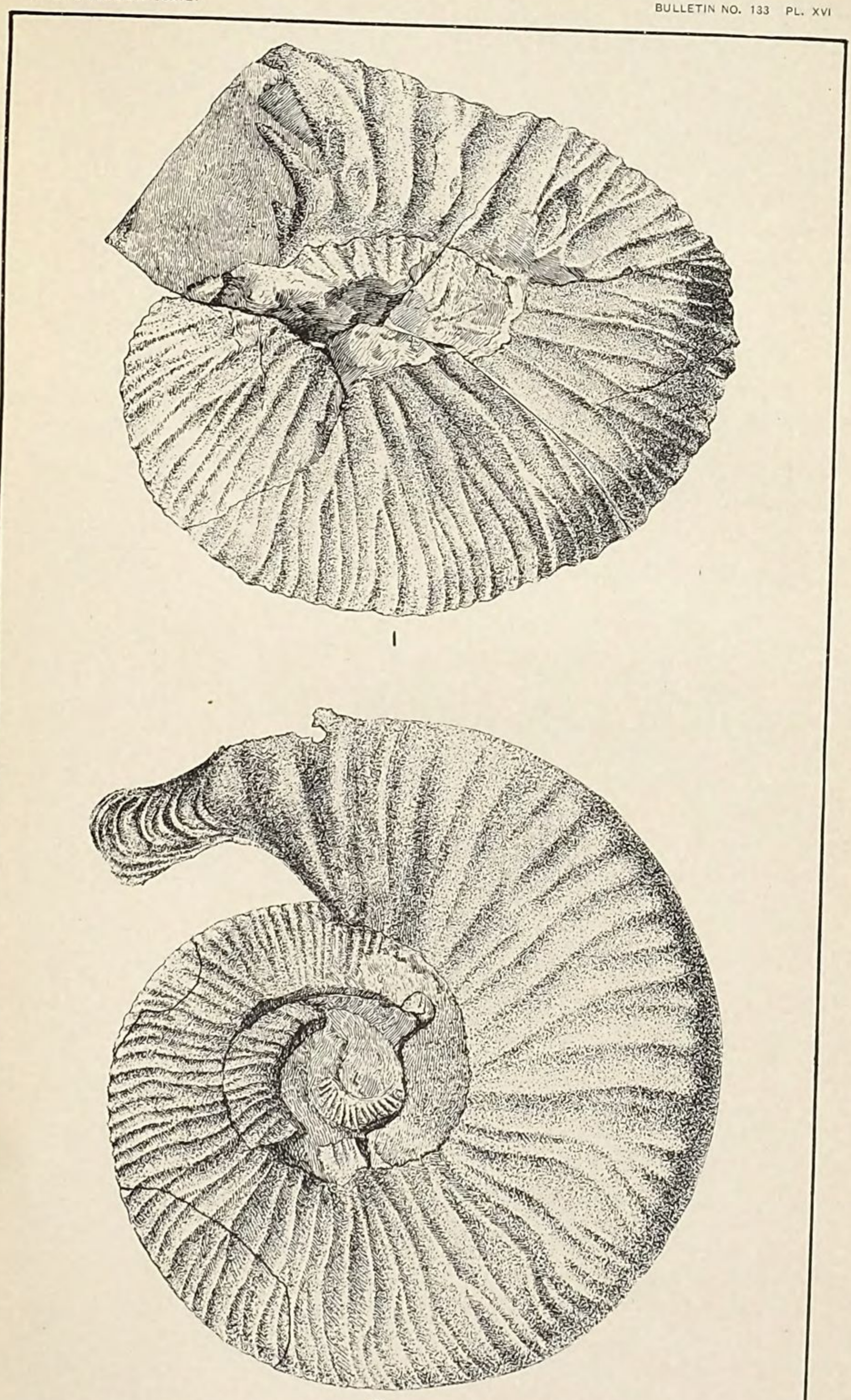
OLCOSTEPHANUS TRICHOTOMUS n. sp 78

Fig. 1. The crushed and distorted type specimen.

HOPLITES HYATTI n. sp 79

Fig. 2. The type specimen. The portions at the left outside of the black lines are restored.

Both figures natural size.



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CEPHALOPODA: OLCOSTEPHANUS AND HOPLITES.

PLATE XVII.

PLATE XVII.

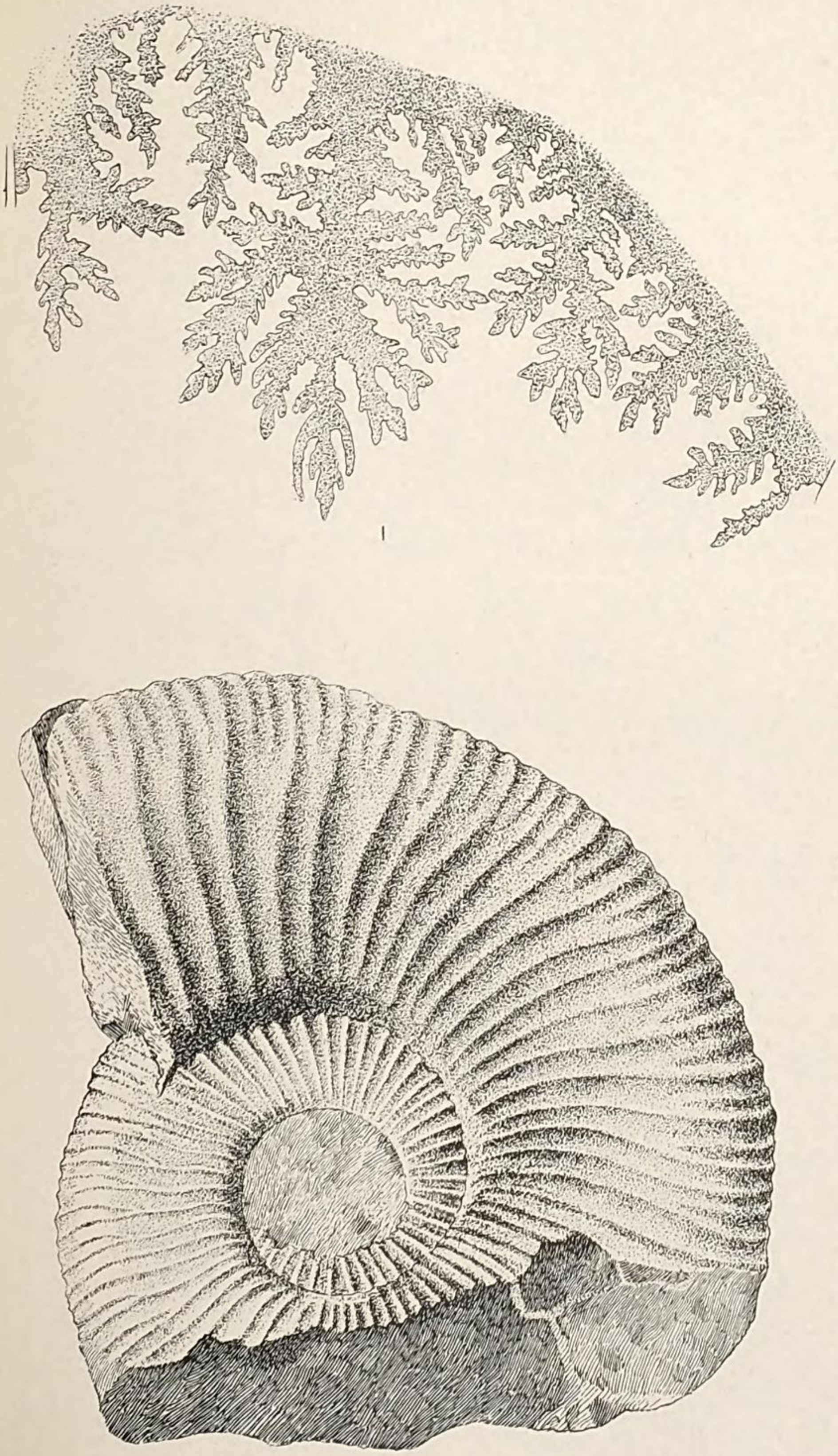
Page.

HOPLITES STORRSI n. sp 79

Fig. 1. Septum, enlarged.

Fig. 2. Type specimen. Natural size.

(*See* Pl. XVIII.)



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CEPHALOPODA: HOPLITES.

PLATE XVIII.

PLATE XVIII.

Page.

APTYCHUS ? KNOXVILLENSIS n. sp 83

Figs. 1, 2. Two views of the type.

HOPLITES ANGULATUS n. sp 80

Figs. 3, 4. Side and ventral views of the type.

HOPLITES STORRSI n. sp 79

Fig. 5. Ventral view of the type. (*See* Pl. XVII.)

HOPLITES DILLERI n. sp 82

Figs. 6, 7. Side and ventral views of the type.

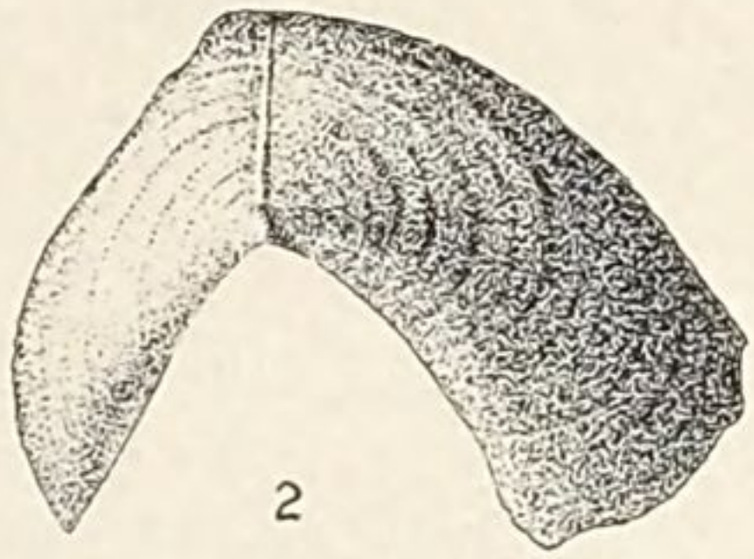
HOPLITES CRASSIPLICATUS 81

Fig. 8. Type specimen, showing parts of three volutions.

All figures natural size.



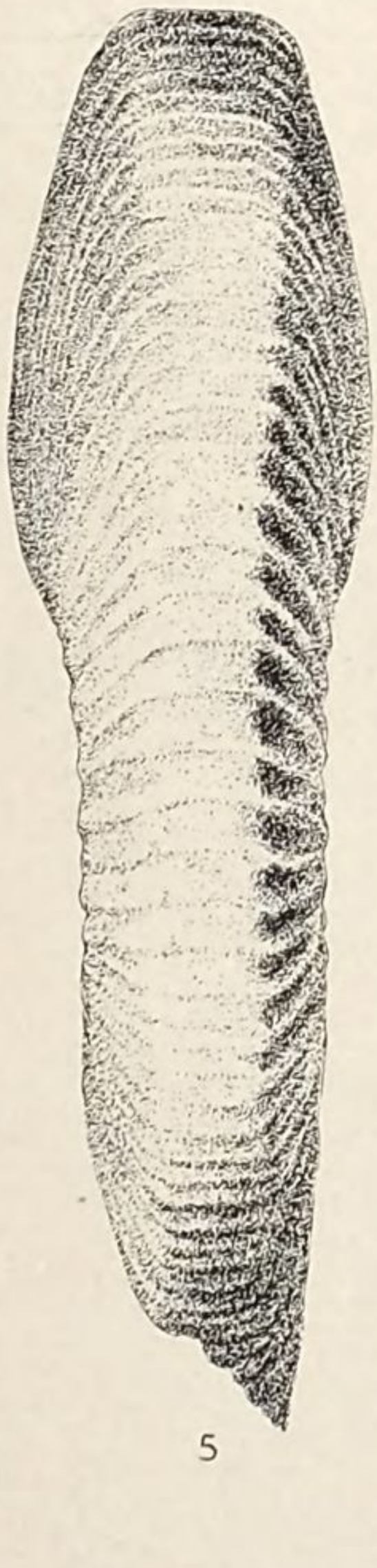
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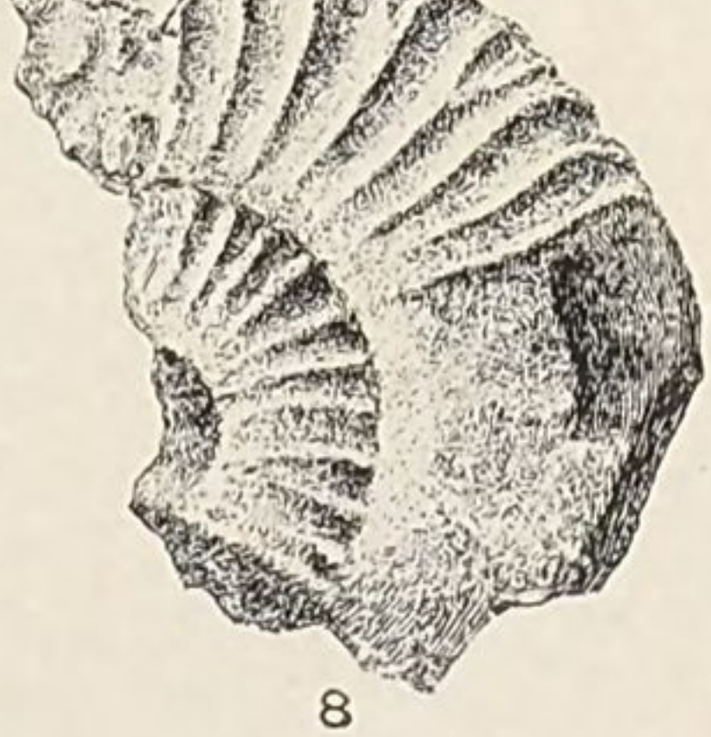
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CEPHALOPODA: APTYCHUS AND HOPLITES.

PLATE XIX.

PLATE XIX.

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BELEMNITES TEHAMAENSIS n. sp..... 84

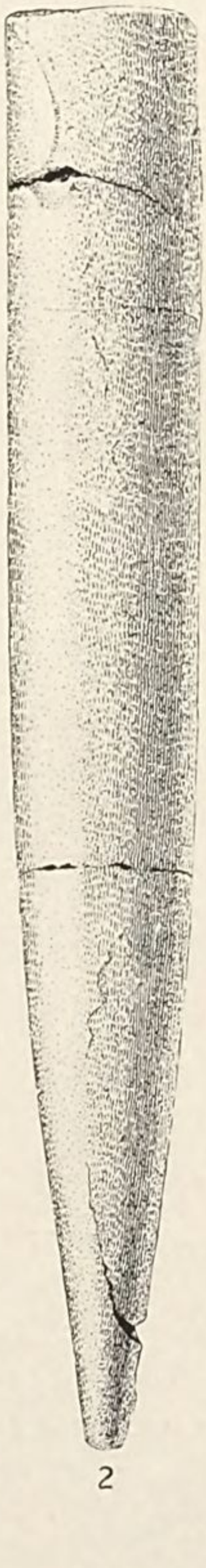
Figs. 1–3. Opposite views and cross section of the type. Natural size.



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CEPHALOPODA: BELEMNITES.

PLATE XX.

PLATE XX.

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BELEMNITES IMPRESSUS Gabb 85

Fig. 1. A fragment with the phragmacone in place.

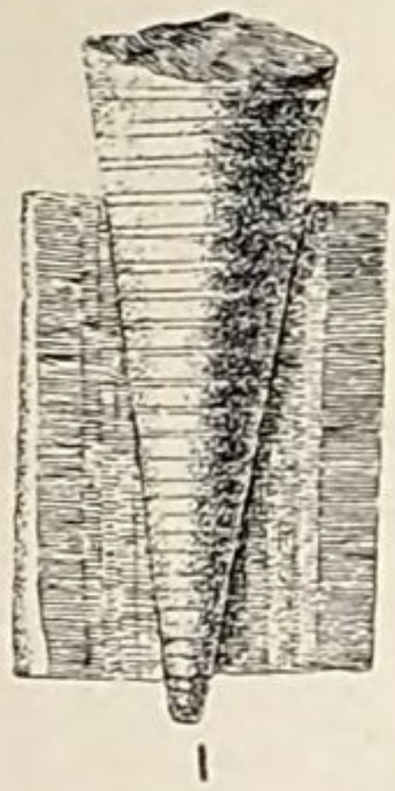
Fig. 2. Cross section just below phragmacone of medium-sized specimen.

Figs. 3, 4. Opposite views of a large specimen.

Fig. 5. Ventral view of a somewhat more slender individual.

All of these, excepting fig. 2, are from the lower part of the Horsetown beds.

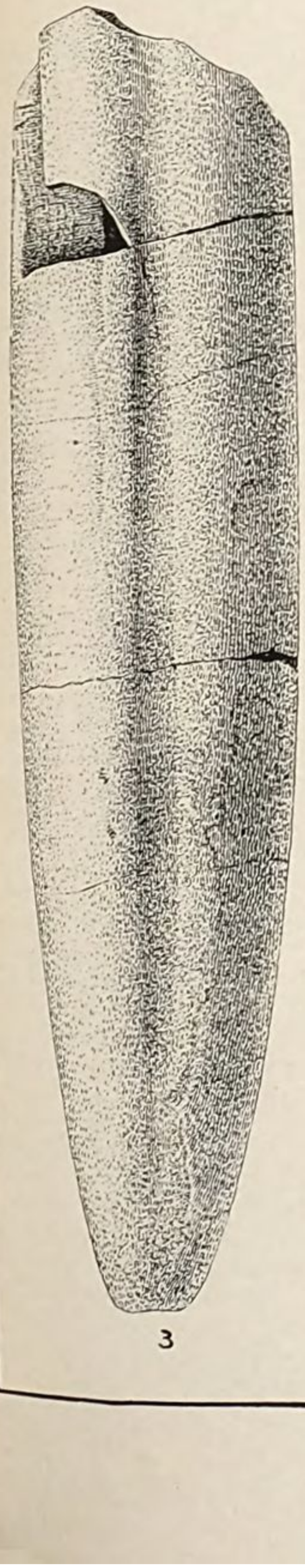
All figures natural size.



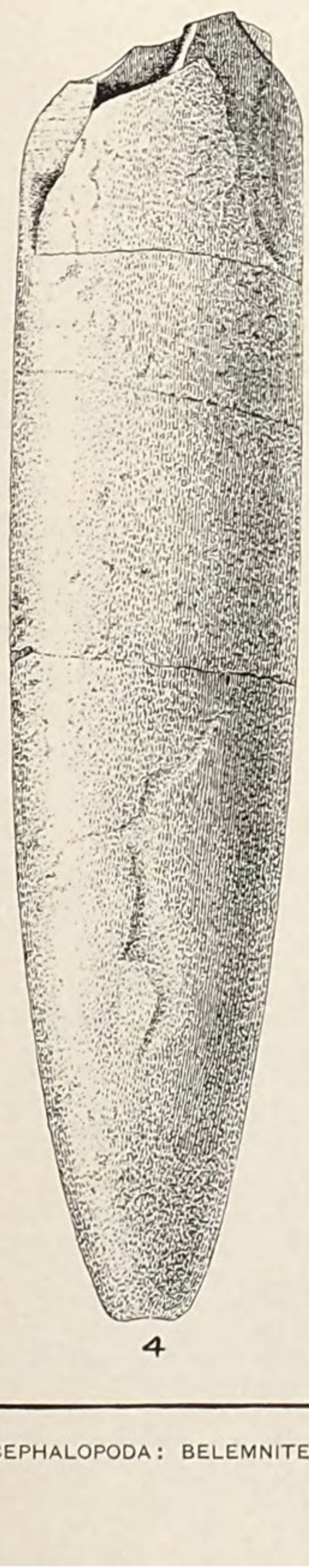
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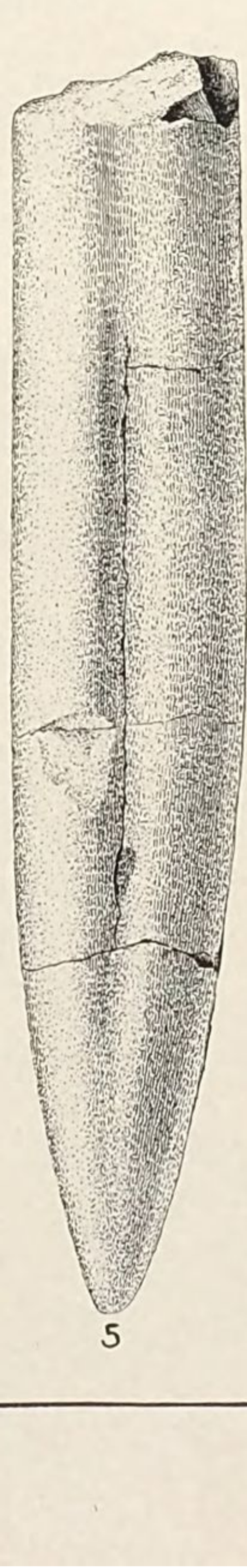
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CEPHALOPODA: BELEMNITES.

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OF THE

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GEOLOGICAL SURVEY

No. 134

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1896

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[Bulletin No. 134.]

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"The publications of the Geological Survey shall consist of the annual report of operations, geological and economic maps illustrating the resources and classification of the lands, and reports upon general and economic geology and paleontology. The annual report of operations of the Geological Survey shall accompany the annual report of the Secretary of the Interior. All special memoirs and reports of said Survey shall be issued in uniform quarto series if deemed necessary by the Director, but otherwise in ordinary octavos. Three thousand copies of each shall be published for scientific exchanges and for sale at the price of publication; and all literary and cartographic materials received in exchange shall be the property of the United States and form a part of the library of the organization; and the money resulting from the sale of such publications shall be covered into the Treasury of the United States."

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Mineral Resources of the United States, 1883 and 1884, by Albert Williams, jr. 1885. 8°. xiv, 1016 pp. Price 60 cents.

Mineral Resources of the United States, 1885. Division of Mining Statistics and Technology. 1886. 8°. vii, 576 pp. Price 40 cents.

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"*Provided*, That hereafter the report of the mineral resources of the United States shall be issued as a part of the report of the Director of the Geological Survey."

In compliance with this legislation, the report Mineral Resources of the United States for the Calendar Year 1894 forms Parts III and IV of the Sixteenth Annual Report of the Survey.

The money received from the sale of these publications is deposited in the Treasury, and the Secretary of the Treasury declines to receive bank checks, drafts, or postage stamps; all remittances, therefore, must be by POSTAL NOTE or MONEY ORDER, made payable to the Director of the U. S. Geological Survey, or in CURRENCY, for the exact amount. Correspondence relating to the publications of the Survey should be addressed

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CHARLES D. WALCOTT, DIRECTOR

THE CAMBRIAN ROCKS OF PENNSYLVANIA

BY

CHARLES DOOLITTLE WALCOTT



WASHINGTON

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1896

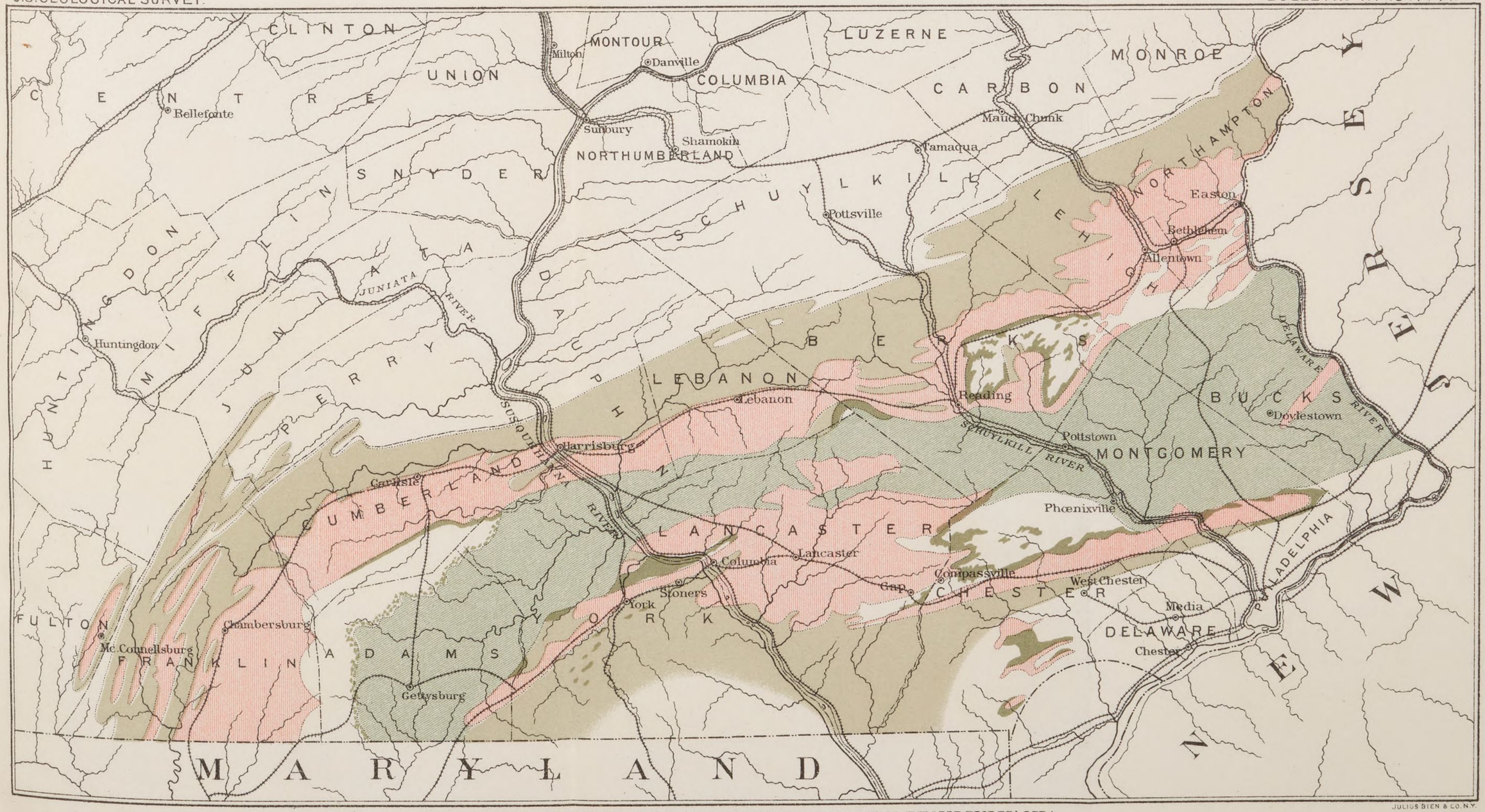
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GEOLOGIC SKETCH MAP OF SOUTHEASTERN PENNSYLVANIA

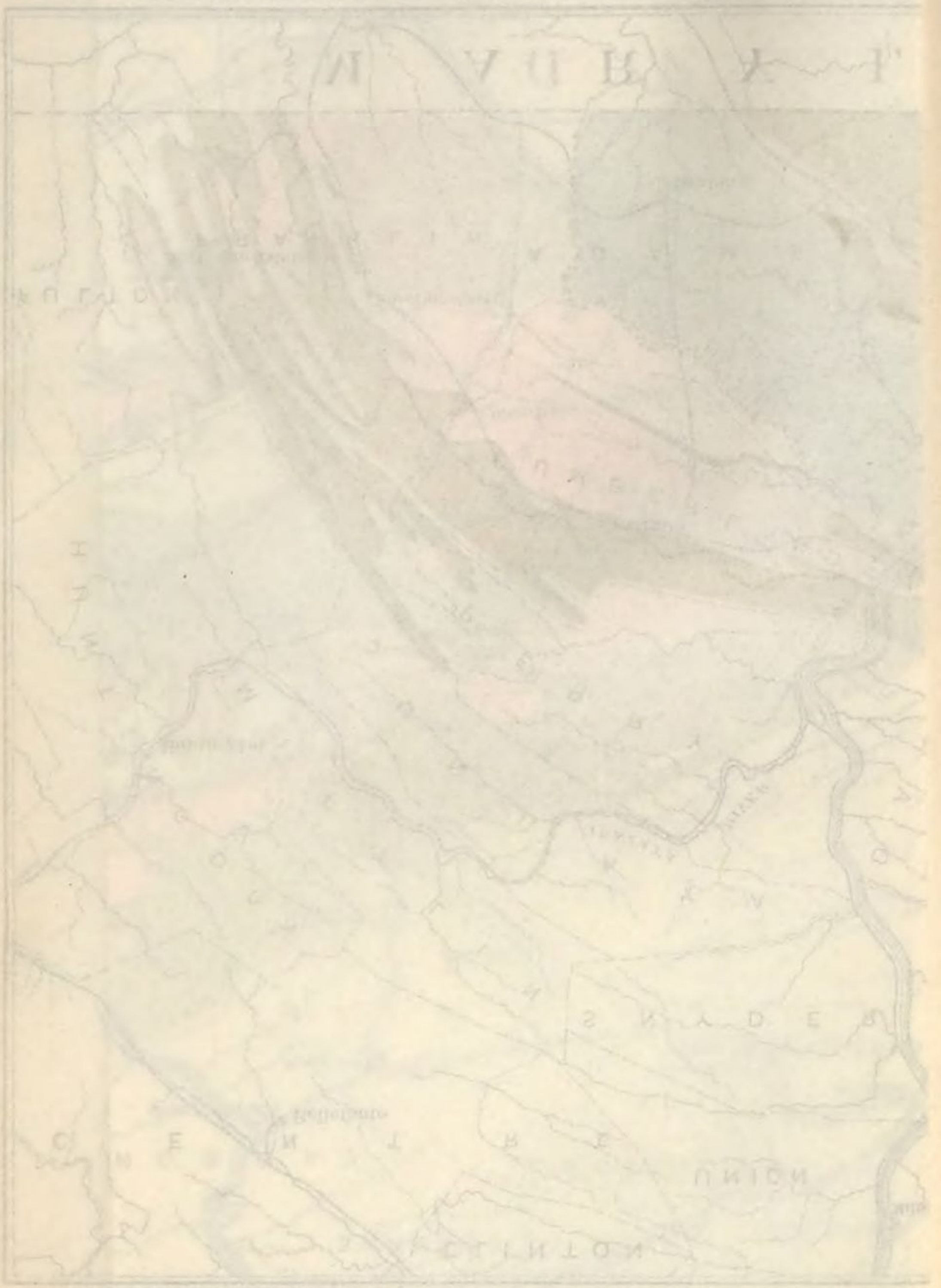
AFTER SECOND GEOLOGICAL SURVEY OF PENNSYLVANIA.

MESOZOIC

SILURIAN (ORDOVICIAN)

SILURIAN (ORDOVICIAN)
CAMBRIAN (LIMESTONE)

CAMBRIAN (QUARTZITE)



THE CAMBRIAN ROCKS OF PENNSYLVANIA.[1]

By Charles D. Walcott.

INTRODUCTION.

Prior to 1892 the strata in Pennsylvania referred to the Cambrian system included the Primal Quartzite of Professor Rogers, and Prof. J. P. Lesley was inclined to consider the sandstone and slate of the South Mountain proper as of Cambrian age. The line of outcrop of the Primal Quartzite extends along the boundaries of the various Archean areas from the Delaware River on the northeast, in Bucks, Lehigh, and Northampton counties, southwesterly, with more or less interruption, across Berks, Montgomery, Chester, Lancaster, Lebanon, York, Cumberland, Adams, and Franklin counties to the Maryland line. Prof. J. P. Lesley's summary of the formation is as follows:

> The lowest Paleozoic formation in Pennsylvania, No. 1, logically identified with the Potsdam sandstone of northern New York, makes its appearance along the edges of the limestone No. II at the north foot of the Azoic mountain range between Bethlehem and Reading, in Lehigh and Berks counties; in Mulbaugh Hill, on the Lebanon county line; in Chicques ["Chickis" of Frazer] Ridge, on the Susquehanna, above Columbia; in the Welsh Mountain, in northern Chester; and in the North Valley Hill, which stretches for 60 miles from the heart of Lancaster to the Bucks-Montgomery county line, north of the city of Philadelphia. Its only fossil as yet discovered is a Scolithus, but its position next beneath the Calciferous limestone is too well marked to admit of doubt. Formerly it entirely covered the mountain districts north and south of the Schuylkill River, because it still spreads in sheets upon their sides, and in many places makes their summits, lying unconformably upon the gneiss.
>
> The South Mountains proper, which separate Cumberland from York and Franklin from Adams County, do not thus exhibit the fundamental gneiss covered by a coating of Potsdam, but are composed of peculiar sandstone and slate strata several thousand feet thick, which occupy the place of the Potsdam in the series, but can not certainly be identified with it. They may be considered the equivalents of the Ocoee and Sewanee strata of East Tennessee. * * * We may consider our South Mountain rocks, therefore, those lying north of the turnpike fault, as of Cambrian age.[2]

---

[1] The object of this paper is to place on record certain observations made during the summers of 1892 and 1893. These observations embraced the belt of Lower Paleozoic rocks lying between the Delaware and Susquehanna rivers and the Potomac River.

[2] A geological hand atlas of the sixty-seven counties of Pennsylvania embodying the results of the field work of the survey from 1874 to 1884: Second Geol. Surv. Penn., Report of Progress X, 1885, pp. xvi, xvii.

The Primal Quartzite is correlated with the Potsdam sandstone of New York in Lehigh and Northampton counties, and is described by Mr. Frederick Prime, jr., as "a hard, compact quartzite, of a yellowish color where weathered, and, when freshly quarried, of a grayish tint. * * * The thickness, where it could be measured, was 21 feet."[1]

The quartzite varies in thickness from 20 to 300 feet, the greater thickness being in the Chickies[2] section of Lancaster County, where, according to Dr. Persifor Frazer, it reaches 300 feet. Southwest of the Susquehanna River it is difficult to measure its exact thickness, owing to complications resulting from faulting and folding and the absence of clearly exposed sections. The character of the formation throughout the State is quite uniform, and the only traces of organic remains that had been found previous to my investigations were the straight, vertical tubes of Scolithus.

In a summary of the Cambrian rocks of Pennsylvania which I published in 1891, occurs the following:[3]

> Prof. H. D. Rogers referred a series of slates between the sandstone called Potsdam and the base of the superjacent limestone to the Primal period, but the geologists of the Second Geological Survey consider them as belonging to the limestone series. If a comparison be made with the Tennessee sections, where the schists and shales between the quartzite and the limestone are characterized by Cambrian fossils, this series of schists will certainly be referred to the Cambrian, as it is subjacent to the great limestone series and superjacent to the quartzite. Professor Rogers described the highest of the Primal newer slate as a "greenish and bluish talcose argillaceous slate, sometimes very soft and shaly, and with a thickness of about 700 feet." Dr. Frazer refers about 1,600 feet of "Hydromica-schist" to the interval between the quartzite and limestone in York County.[4]

The upper part of the Primal slates does not appear to be developed to the northeastward in Lehigh, Northampton, Bucks, Montgomery, Berks, and Chester counties. It first appears with any considerable thickness in Lancaster County, near the Susquehanna River, and south of the quartzites of the Chickis Hills. Thence it extends southwesterly across York and Adams counties to the Maryland line, increasing in thickness in Maryland and Virginia.

As a whole, the Cambrian system in Pennsylvania appears to be represented by the lower quartzite and the superjacent shales and schists as originally defined by Professor Rogers, and it may be that the lower portion of the superjacent limestone will be included.

In a letter from Professor Lesley, dated May 8, 1890, he says:

"Reading Ells's paper and Brainerd and Seely's paper in Bull. Geol. Soc. America, just published, with your remarks at the meeting, I naturally reverted to my South Mountain surveys (twenty years ago) east of Chambersburg, Pa. (Fulton and Adams counties), and the strange and powerful impression made on me then by the outcrop of a low ridge of purple shales running from the pike southward, just back (east) of the western mountain ridge. I never saw anything like them, and feel strongly inclined to consider them the Sillery purple shales (Cambrian) of the North. I can not find or remember any description of this outcrop by Frazer. It lies in Fulton County, outside the Adams County line."

---

[1] Geology of Lehigh and Northampton counties: Second Geol. Surv. Penn. D[3], Vol. I, 1883, p. 205.

[2] This is the spelling adopted by the United States Board on Geographic Names.

[3] Bull. U. S. Geol. Surv. No. 81, 1891, p. 289.

[4] General notes—Sketch on the Geology of York County, Pa.: Am. Philosoph. Soc., Proc., Vol. XXIII, 1886, p. 401.

In his report on the Geology of Pennsylvania,[1] Professor Lesley summarizes his opinion upon the geology of the South Mountains and Formation No. 1. In this, Formation No. 1 is referred to the Upper Cambrian, and a detailed description is given of its occurrence along the South Mountains and across the State to the Delaware. The superjacent limestone, No. 2, is referred to the Ordovician.[2] Fuller reference will be made to Professor Lesley's descriptions in speaking of the rocks of York County.

During the summer of 1892 I made an examination of the Cambrian rocks between the Susquehanna and the Potomac, and during the field season of 1893 followed it by a rapid reconnaissance of a portion of the area between the Susquehanna and the Delaware, for the purpose of determining whether the lower quartzites with their superjacent limestones were of the same geologic age as the quartzites southwest of the Susquehanna. When I took up the work, after an examination of the published literature, including geologic sections and maps, I decided to begin the investigation in York County, along the Susquehanna, as the section there and about the Hellam Hills appeared to be less disturbed and to present more favorable conditions for obtaining good results than the area to the southwest.

YORK COUNTY.

On the map of the First Geological Survey of Pennsylvania[3] the area now under consideration in York County was included under the colors of the "Primal sandstone" (Potsdam) and the Auroral limestone, the latter being equivalent to the Black River-Chazy limestone and Calciferous sand-rock of the New York section, as explained in the key to the geological map.

During the progress of the Second Survey Dr. Persifor Frazer, jr., was placed in charge of the survey of York and Adams counties. On his map of York County, published in 1879, the formations under consideration are subdivided more than on the Rogers map of 1858. They are bounded on the north by the Mesozoic "New Red" sandstones, and on the southeast by "Azoic slates, etc.," and consist, in descending order, according to the legend, of—

4. Limestone (Silurio-Cambrian?).
3. Hydromica-schists, etc.
2. Quartzite (Potsdam?).
1. Chlorite schists, etc.

.In the report of progress for 1874–75, Dr. Frazer states that the schists (3) carrying the iron ore do not belong to the Auroral limestones, but to a series of schists beneath, and that there is, probably,

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[1] A Summary Description of the Geology of Pennsylvania, Vol. I, 1892, chapters 15 and 16.
[2] Loc. cit., p. 307.
[3] Henry D. Rogers, 1858.

a line of unconformity between the limestones and the subjacent "Crystalline schists."[1]

In discussing the question of the contemporaneity of the schists with the limestones called by Dr. Rogers the "Auroral," he concludes that two questions are involved: "First, are two limestones of different ages confounded under the name of 'Auroral;' second, if so, are they conformable the one to the other?" He decided that the crystalline schists containing the ore bodies seem to form the floor on which the York limestone lies, while another limestone seems to be bedded with them.[2] Mention is also made of a limestone conglomerate consisting of a blue limestone holding rounded pebbles of white limestone within it, that occurs in a quarry half a mile north of the Columbia Bridge.[3]

The preceding is quoted to show that Dr. Frazer had a conception that there is a limestone beneath the York limestone, embedded in the unconformably subjacent schists, that is not of the same age as the "Auroral" limestones, which were referred to the Chazy-Calciferous horizon by Rogers and others. The evidence for this is materially weakened by the statements contained in his report on Lancaster County, that the Lancaster limestone—

> * * * has great masses of hydro-mica schists, argillites, rhomboidal slates, and gray, weathered, leached-out pyritiferous strata. * * * Slates and argillites, and, perhaps a little more rarely, true hydro-mica rocks may come into any horizon of the limestone. * * * This intercalation of foreign beds does not seem to be at present reducible to any rule, though in general such transitions seem to be more frequent in the lower than in any other parts of the measures.[4]

He considers the Lancaster limestones as probably the equivalent of the Calciferous and Trenton limestones of the New York series, and mentions that the York limestone is a slender offshoot.[5] The Hellam quartzite of York is called the "Chikis" quartzite, and is described as a basal formation upon which a series of schists occur that to the south "are, at all events, those slates in which the iron ores of Lancaster and York are invariably found—the transition series between the 'Primal and Auroral.'"[6] In his final report,[7] Professor Lesley describes the "Chiques" sandstone as the same formation as the Hellam quartzite of York County (as named by Frazer) and equivalent to the Upper Cambrian quartzite of Walcott. He prefers to use the older name "Chiques" for these sandstones, stating that it is best to get rid of the old name "Potsdam" sandstone, as there does not seem to be any satisfactory evidence that the proper Potsdam sandstones of the Canada line and Lake Champlain extend as far south as southern

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[1] Second Geol. Surv. Penn., Report of Progress in the District of York and Adams counties, 1876, p. 130.

[2] Loc. cit., pp. 132, 134.

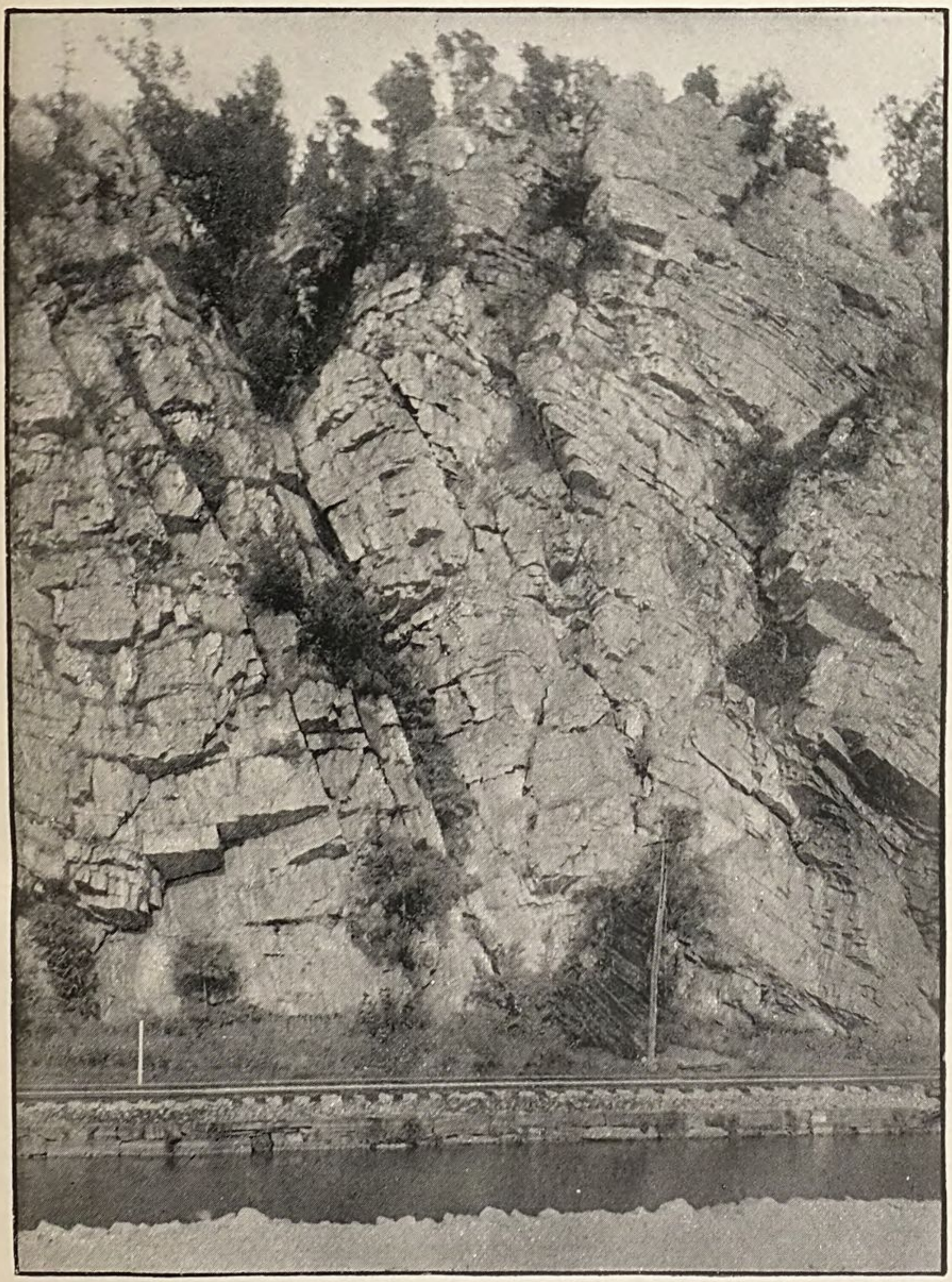
[3] Loc. cit., p. 132.

[4] Second Geol. Surv. Penn., Report of Progress in 1877, Geol. of Lancaster County, 1880, p. 5.

[5] Loc. cit., p. 4.

[6] Loc. cit., p. 7.

[7] Geol. Surv. Penn., Summary Description of the Geology of Pennsylvania, Vol. I, 1892, p. 165.



CENTRAL PORTION OF THE CHICKIES QUARTZITE AT CHICKIES ROCK, ON THE SUSQUEHANNA RIVER, LANCASTER COUNTY, PENNSYLVANIA.

Pennsylvania. He says that the section at "Chiques Rock" is not quite comprehensible at one or two points. I found that it is so complicated by the folding of the strata and by thrust-faulting that it is not a typical section. It exposes, however, the lowest of the Cambrian now known to me in central Pennsylvania. The quartzite at "Chiques Rock," near Chickies, is the Scolithus quartzite, and is stratigraphically at the summit of the series of quartzites and slates forming the "Chiques Rock" section, although apparently at the base in the section, owing to the disturbance of the strata. The quartzites and slates to the south, between "Chiques Rock" and the limestones at Columbia, are older, and have been raised up from beneath and thrust over on the Scolithus quartzite at "Chiques Rock." This is determined by the succession shown in the section exposed on the flanks of South Mountain, in Franklin County, west of Monterey, reference to which is made in the notes on the geology of South Mountain.

In relation to the stratigraphic position of the slates, etc., beneath the Lancaster limestone, I will quote the statement of Professor Lesley:

> The geographical proof that the slates overlie the quartzite is complete, and establishes the correctness of Professor Rogers's "Upper Primal slate formation." The geological evidence is equally conclusive; for the general dip of the Chiques rock is southward, under the slates; and of the slates southward under the limestone.[1]

The exposure of the Chickies Quartzite at Chickies Rock, on the Susquehanna, is remarkably fine. It rises in a bold bluff 100 feet or more in height, forming a low anticline with a slight synclinal depression near the center. Nearly vertical cleavage planes extend from top to bottom through many of the layers in the central portion. This is shown in Pl. II.

The continuation of "Chiques Rock" to the westward, in York County, forms the Hellam Hills,[2] and shows a broad anticline of quartzite surrounded by schists. Numerous sections along the southern and western sides of the Hellam Hills show that the quartzites pass beneath a series of shales, slates, and sandy and calcareous layers, which, in turn, pass beneath the limestones of the valley.

It was my good fortune to have the acquaintance of Prof. A. Wanner, superintendent of public schools at York. He volunteered to be my guide to localities where he knew there were good exposures of the quartzites, schists, and limestones; and he accompanied me for a week.

The study of the rocks in York County was begun under the impression that the limestone was the "Auroral" limestone of Rogers, and equivalent to the Chazy-Calciferous of the New York section. I thought, however, that there was a probability of its being Cambrian in age, from the fact that in Tennessee, Vermont, and New Jersey the lower

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[1] Loc. cit., p. 172.

[2] I did not learn, when in York County, of any local name for this ridge of hills, and as most of the ridge is within the township of Hellam I shall speak of them as the Hellam Hills.

portion of the great limestone series above the quartzite and shales, is undoubtedly of Cambrian age.

A reconnaissance was first made of the section at "Chiques Rock," thence south to Columbia, Pa., and then on the western side of the river from Wrightsville north to the quartzites. A careful study of the "Chiques Rock" section led me to think that there was a considerable disturbance and a complication of the normal section, by overthrust of the lower beds upon the higher, between the Scolithus quartzite at "Chiques Rock" and the limestone at Columbia. On the western side of the river the section appeared to be unbroken from the Hellam Hills to Wrightsville, and to be as represented by Dr. Frazer in his section along the right bank of the Susquehanna.[1] In this the succession is from the quartzite (1) to the shales (2) and to the limestone (3), in Wrightsville, at Columbia Bridge. The sandy shales and argillites (2) pass conformably beneath the massive limestone (3), which forms a deep synclinal fold before being cut off to the south by a fault.

The second section examined was No. 2 of Dr. Frazer's, extending from Emigsville south through Red Lyon Station.[2] In the description of this section[3] he refers the sandstone in the railroad cut just north of Emigsville to the Triassic New Red sandstone. At the northern end of the cut he noted a fine-grained sandstone dipping W. 15°, N. 52°. To the southward of this he describes a calcareous, sandy, pink shale dipping S. 5°, E. 20°. This is subjacent to 27 feet of blue, finely laminated limestone, with white streaks, upon which rests a red bed of calcareous conglomerate 2 feet thick; this, in turn, is subjacent to a belt of reddish, shaly sandstone, 63 feet in breadth, and a compact, fine-grained sandstone, 9 feet in thickness, which is capped by 156 feet of arenaceous shales of a somewhat flaggy character.

Dr. Frazer says:

> There would seem to be, therefore, an anticlinal in the Triassic measures—the only instance of one recorded within the limits of this district. The contact line of limestone and Mesozoic sandstone lies within or just north of the town of Emigsville. The first recorded dip in the older formation when projected upon the line of section is 2,160 feet, or a little more than a third of a mile from the last dip.[4]

I mention the details of Dr. Frazer's section because it is the one which led to the determination of the stratigraphic position of the Chickies quartzites and the York shales,[5] which are subjacent to the

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[1]Second Geol. Surv. Penn., 1876; section 1 accompanying Report of Progress in the district of York and Adams counties for 1874.

[2]Loc. cit., section 2.

[3]Loc. cit., p. 88.

[4]Loc. cit., p. 89.

[5]The name "York shales" is proposed for the band of shales resting upon the quartzites surrounding the Hellam Hills. It is particularly well developed in York County, but appears to be absent in many of the sections about South Mountain and about the same series of quartzites in Lancaster County.

Lancaster limestone.[1] The fault between the Paleozoic (Lower Cambrian) rocks and the New Red sandstone of the Mesozoic occurs in the railroad cut at the point indicated in Dr. Frazer's section as the crest of an anticline in the New Red sandstone. No such anticline exists. The southern leg of Dr. Frazer's anticline is formed of rocks that bear no resemblance to the Mesozoic Red sandstone, and fossils of Lower Cambrian age are abundant in the 9 feet of compact, fine-grained sandstone described by him. The section, from the fault line southward, is as follows:

Section from Emigsville south through Red Lyon Station, Pa.

	Thickness in feet.
1. Gray, banded, and mottled limestones, with purplish bed of limestone at summit 3 feet thick. Strike, E. and W. (mag.); dip, 25° S. This limestone weathers into a more or less arenaceous shale	33
2. Gray and buff sandy shales passing (at 21 feet) into shaly sandstone and then into sandy shale, where a belt of calcareous quartzite occurs in layers varying in thickness from 2 to 12 inches. Fossils: *Camarella minor*, and fragments of Olenellus showing portions of the head and thoracic segments[2]	105
3. From the fossiliferous beds just mentioned, for a distance of 500 feet, the hillside on the east side of the railroad is covered with the débris of sandy shales, and several exposures occur along the roadside. From the last of these to the first outcrop of limestone, a distance of 250 feet, the débris of sandy shales and thin-bedded calcareous quartzite occur abundantly in the southward-facing hill slope. Fossils: Numerous fragments of Olenellus and casts of *Camarella minor* occur in the calcareous quartzite interbedded in the shale. As the last observed dip was 25° S., it is assumed that the section is unbroken, and a thickness is assigned to this division of	315
4. Massive-bedded, dove-colored, banded limestones. Strike, N. 20° W. (mag.); dip, 25° S.[3] Although the section is more or less concealed by soil, numerous outcrops occur in quarries to the south. These show a banded limestone in the lower portion of the section, with numerous irregular, small, concretionary bits of limestone, usually elongated with the bedding plane. The average dip of the bed is from 20° to 25° S. A beautiful section is shown in a quarry about one-fourth of a mile east of Emigsville, and in a quarry on the turnpike west of the railroad, in the outskirts of the town. A little higher up in the section the limestones are massive, light-colored, and, in places, almost a crystalline marble.	

At a quarry in a field east of the railroad track and near where the road turns to the eastward toward Codorus Creek, the strike of the limestone is N. 15° W. (mag.), and the dip 15° S. One of the layers is quite fossiliferous and gave fine specimens of *Iphidea bella*, *Salterella conica* n. sp., *Protypus senectus*, heads of small trilobites of the genera Solenopleura and Zacanthoides, and numerous fragments of the head and thoracic segments of a species of Olenellus.

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[1] The term "York limestone" was proposed by Dr. Frazer for this limestone; but, as he states that it is a prolongation of the Lancaster limestone into York County, and that it is more fully developed in Lancaster County, I think it best to retain the term Lancaster limestone, as it is hardly necessary to call the same limestone by different names in adjoining counties.

[2] On the line of strike of these beds, 2 miles northwest of Emigsville, the following fauna was found in the calcareous sandstones: *Camarella minor*, *Obolella crassa* (?), *Hyolithes communis*, and fragments of Olenellus.

[3] Dr. Frazer's section indicates a dip of 85°. I was not able to discover the locality where it occurred.

Section from Emigsville south through Red Lyon Station, Pa.—Cont'd. Thickness in feet.

Farther to the westward, in an old quarry east of the Northern Central Railroad track, massive layers of limestone are shown that have a strike N. 20° W. (mag.), dip 20° S., and contain fragments of the genera Olenellus and Protypus. The next higher exposure in that section is in a large, deep quarry just west of the railroad track, between one-fourth and one-half mile south of Emigsville. About 60 feet of limestone is exposed. The strike is E. and W. (mag.), with a dip of 10° S. In the lower portion of the quarry massive layers of arenaceous limestone occur, and about 10 feet from the summit of the section are alternating bands of earthy and pure limestone in which numerous fossils occur. In the collection obtained I have recognized plates of Cystids, Kutorgina n. sp., *Billingsella festinata* Billings, Olenellus (fragments), and *Protypus senectus* Billings. The fragments of Olenellus indicate individuals as large as any known. The fossils range through about 20 to 25 feet of the limestone.[1] The layers above the fossiliferous band are largely brecciated and form a limestone conglomerate.

In the railroad cut the limestone is shown, and a little to the north of it cleaved slates, the bedding of which strikes east and west (mag.), and dips 10° S. There is an interval of 20 feet between the limestone and slates covered by debris. The limestone appears to pass beneath the slates, and from the areal distribution of the slates and limestone to the south and southwest it is probable that this upper band of slates has a wide distribution. Its thickness is unknown.

Estimated thickness of the entire series of limestone 750

The banded limestone of No. 4 is beautifully shown in a quarry about one-fourth of a mile southeast of Emigsville. This is exhibited in Pl. III, where the more siliceous layers are brought out in strong relief by the solution of the purer limestone layers.

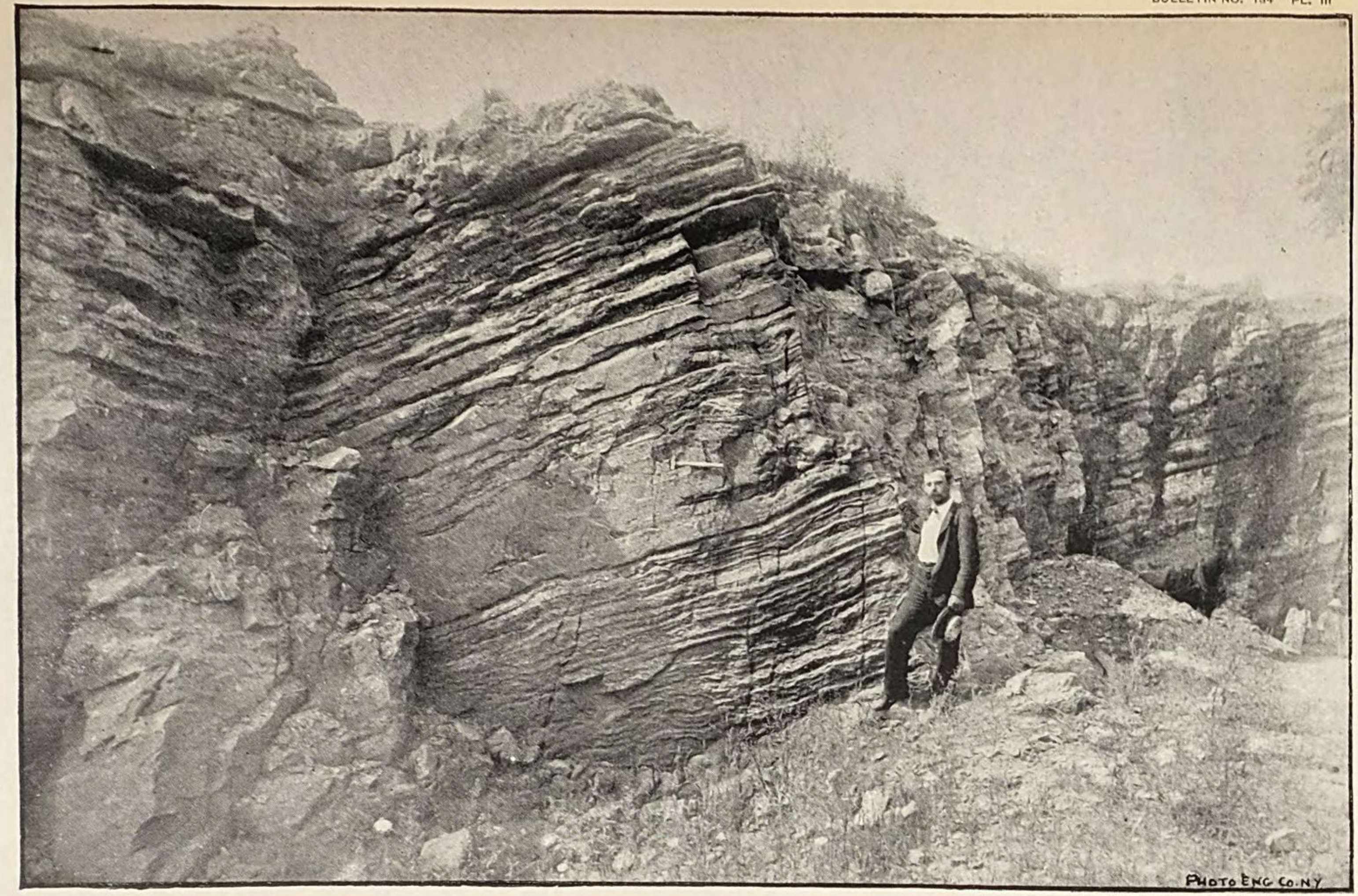
On the geological map of York County an area of the Hellam quartzite is indicated 2 miles northwest of Emigsville. We found this to be a continuation of the calcareous Olenellus quartzites beneath the limestone of the section at Emigsville. They form a narrow, continuous belt, and were traced northwestward nearly over to New Holland, on the Susquehanna.

A section from a point 1 mile east of Emigsville to the limestone north of New Holland shows an anticlinal structure with the Olenellus quartzite at the center of the anticline, and above, in turn, the shales and limestones. This quartzite is colored on the map as of the same age as the Hellam quartzite. It is, as we now know, a thinner belt of quartzite resting in the calcareous and sandy shales above the quartzite of the Hellam Hills.

The next point determined was the actual relation of the Olenellus quartzite at Emigsville to the massive Scolithus quartzite of the Hellam

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[1] At a locality 4 miles north of York, on the left bank of Codorus Creek, and one-eighth of a mile below Meyers's mill, near Emigsville, Prof. A. Wanner and Mr. Charles Schuchert found the following species *Eocystites* ——, *Iphidea bella* Billings, two undescribed brachiopods, *Billingsella festinata* Billings *Hyolithes americanus* Billings, *Salterella conica* n. sp., *Protypus senectus* Billings, *Olenellus thompsoni* Hall (?). This fauna is a characteristic middle Olenellus-zone fauna, and may be compared to that of the upper Winooski marble of the Vermont section. They also found, south of Eisenhardt's schoolhouse, on Liverpool road, 3 miles northwest of York, *Billingsella festinata* Billings, *Hyolithes americanus* Billings, *Salterella conica* n. sp., and *Olenellus thompsoni* Hall (?).



BANDED LOWER CAMBRIAN ROCKS ONE-FOURTH MILE SOUTHWEST OF EMIGSVILLE, YORK COUNTY, PENNSYLVANIA.

Hills. In passing from Pleasureville toward York, on the steep side-hill 2 miles west of York, there are, in the roadside, exposures of the shales and calcareous sandstone above the massive quartzite of the Hellam Hills. At a point probably 100 feet beneath the ferriferous shale in which the numerous ore pits occur, on the south side of the Hellam Hills, a species of Obolella, very closely allied to *Obolella crassa*, and fragments of Olenellus were found in the decomposed calcareous sandstone. At a locality about 1 mile south of Mount Zion church, in Hellam Township, and 4 miles northwest of York, numerous specimens of *Camarella minor* and fragments of Olenellus occur in a calcareous quartzite identical in character with that of the Emigsville section. These two localities prove that the Scolithus quartzites of the Hellam Hills and of "Chiques Rock" are beneath the Olenellus calcareous quartzites of the Emigsville section, and are therefore of Lower Cambrian age.

Search was next made for fossils near the base of the limestone above the ferriferous shales resting on the quartzites of the Hellam Hills. They were found a short distance above the shales in a small quarry of thin-bedded limestone by the roadside, 1⅛ miles north of Stoners Station, on the York and Wrightsville Railway. The strike is a little north of west, and the dip 45° S. Finely preserved specimens of Linnarssonia, closely allied to *Linnarssonia sagittalis*, are abundant, and easily recognized fragments of a species of Olenellus are associated with them. Crossing the section to the south, occasional exposures were seen of massive-bedded, light-colored limestones of much the same character as those exposed in the quarries north of Wrightsville, 3 miles to the eastward. The dip increased to 85° at the railroad track, which indicated that a compressed syncline had been passed over in the section.

Fine exposures of the massive and more finely bedded limestones are shown in the quarries in the suburbs of York. Where the soil has been recently removed the characteristic erosion by solution is frequently seen. This is exhibited in Pl. IV, where the white limestone looks very much like the hummock ice of an ice floe. Pl. V is an illustration of one of the minor folds in the more finely bedded limestone. This is above the more massive limestones shown in Pls. IV and XI. The massive limestones of Pls. IV and XI are correlated, although in Pl. XI the rock is seen to carry a limestone conglomerate.

Through the efforts of Prof. A. Wanner, the fauna of the main body of the limestone in York County has been largely increased since my visit. Mr. Charles Schuchert also made a collection at Professor Wanner's localities. A study of all the material gives the following lists of species:

Fossils from Cutcamp's quarry, north of Cottage Hill, York, Pa.

Cystidian plates.
Microdiscus, like *M. parkeri* Walcott.
Olenellus sp. undet.
Zacanthoides sp.?
Ptychoparia adamsi Bill.
Ptychoparia teucer Bill.
Agraulos sp.?

The fauna is strongly marked by the presence of the two undetermined species of Zacanthoides and Agraulos. It is essentially of an upper Olenellus-zone type.

Fossils from roadside north of Highland Park, York, Pa.

Olenoides like *O. marcoui* Whitfield.
Protypus senectus Bill.
Ptychoparia.

A fauna similar to this occurs at the upper limit of the Olenellus zone in the Parker section of Georgia, Vt. The absence of Olenellus is unusual, as that genus is almost always present in all Lower Cambrian rocks; and it may be a fair inference to consider the horizon at which these fossils occur as beds of passage between the Lower and the Middle Cambrian.

Fossils from cellar diggings, corner Penn and North streets, York, Pa.

Sponge undet.
Eocystites.
Acrotreta sp.?
Agnostus sp.?
Zacanthoides sp. undet.
Bathyuriscus sp. undet.
Ptychoparia sp. undet.
Ptychoparia sp. undet.

This fauna is to be referred to the lower horizon of the Middle Cambrian. It is marked by a very characteristic form of Agnostus and Bathyuriscus.

When examining the section on the east side of the Susquehanna, in Lancaster County, south of Columbia and north of Washington Manor, with Messrs. A. Wanner and Arthur Keith, we found a locality of Lower Cambrian fossils in a narrow belt of limestone about half a mile north of Washington Manor. In the material collected *Hyolithes communis* and fragments of Olenellus showing portions of the head and thoracic segments were recognized.

A glance at Dr. Frazer's map of York County shows that, in all probability, all of the limestones, quartzites, and schists of the central portion of the county are of Cambrian age. The Hellam quartzite ridge is, as stated by Dr. Frazer, evidently an anticlinal ridge, broken in the northwest side by a fault that has brought the quartzites up against the higher horizons of the shales and limestones. The anticlinal structure apparently extends to the southwest, past York and toward Hanover.

The discovery of Lower Cambrian fossils in the compressed syncline of limestone in Lancaster County, south of Columbia, indicates that the limestone on the west side of the river is of the same geologic age, and that the shales and schists beneath it (called chlorite-schists, etc., by Frazer) are of Lower Cambrian age; and I doubt if there is in York County a sedimentary rock—other than the Mesozoic New Red sandstone—of later age than the Cambrian, unless it be the Peach Bottom slate and chlorite-schists of the southeastern corner of the county; and from the closely related structure of Lancaster County it is very

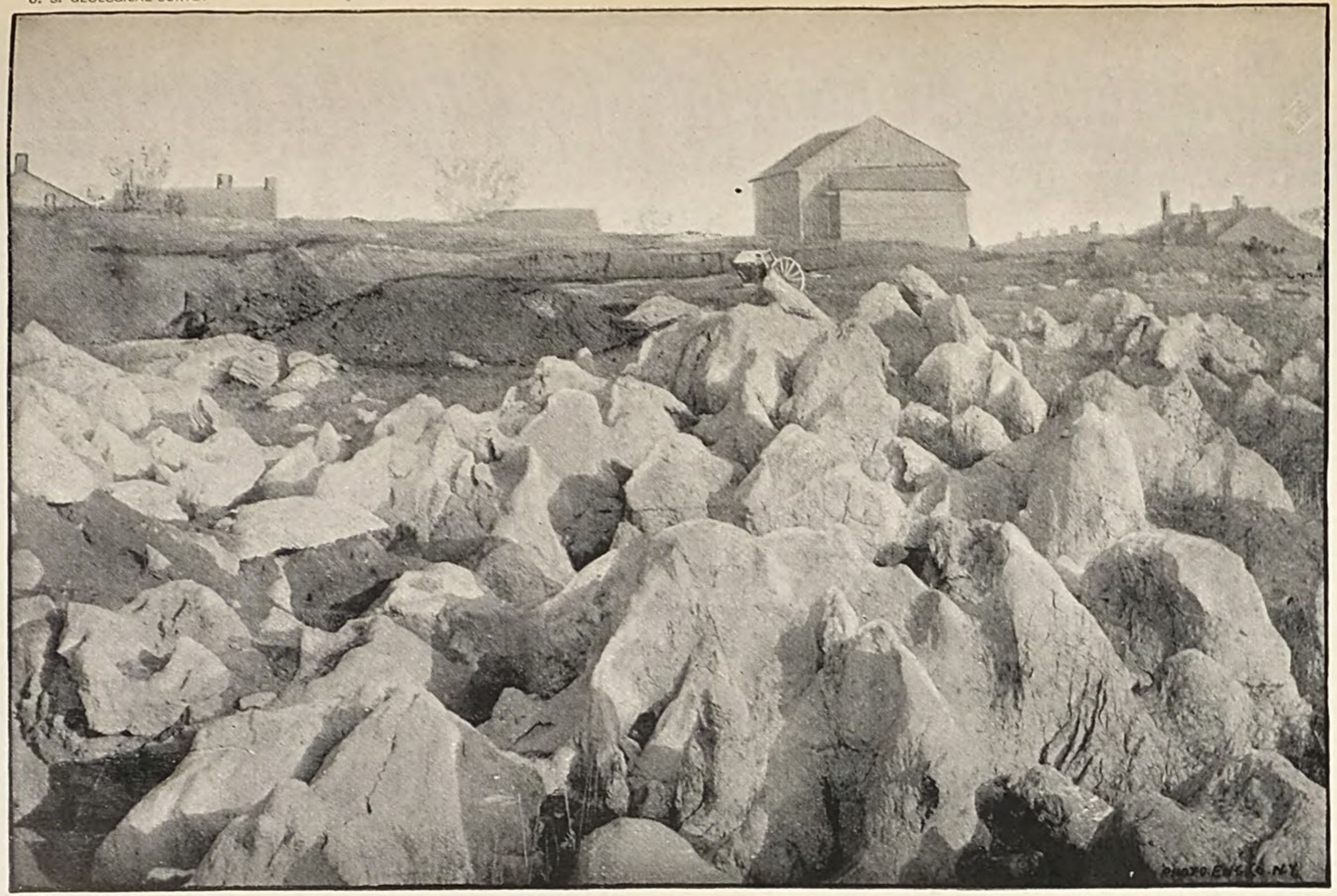


ILLUSTRATION OF EROSION BY SOLUTION BENEATH THE SOIL OF A MASSIVE BED OF LOWER CAMBRIAN LIMESTONE, EXPOSED IN A LIMESTONE QUARRY ON THE EAST SIDE OF YORK, PENNSYLVANIA, WITHIN THE CITY LIMITS.

probable that all the Lancaster limestones will fall within the Cambrian, unless it be some portions of the upper series of limestone, which may pass into the Ordovician. This generalization will also apply to the limestones of the adjoining counties of Berks and Chester, and, in fact, to the entire extension of this series northeastward to the Delaware. All of the quartzites that have been referred to the Potsdam will necessarily fall into the Lower Cambrian, as they are beneath the limestones.

When it is borne in mind that the quartzites that have been called the Potsdam by the Pennsylvania Survey are of Lower Cambrian age, that a series of schists and limestones superjacent to these are of Lower Cambrian age, that the Potsdam horizon of the New York series is represented by limestones in the Auroral series of Rogers, and that the Calciferous-Chazy terrane of the New York section is represented only by the upper portion of the Auroral limestones, geologists will have little difficulty in determining the geologic horizons of the various outcrops of quartzites, schists, shales, and limestones, provided careful attention is paid to their sedimentary character and to the discovery of occasional localities of fossils.

SOUTH MOUNTAIN.

Professor Lesley states that—

> The South Mountains, separating the Cumberland Valley from the lower country of York and Adams county, are the northernmost end of the Blue Ridge range of Virginia. * * * The whole measures upon the map 10 miles in breadth by 50 in length, upon a curve extending from the Maryland line to its northeastern end, 15 miles west of Harrisburg.[1]

From the Pennsylvania line southwest across Maryland, South Mountain extends, as the Blue Ridge, to Harpers Ferry, and thence southwest across Virginia. It practically includes, also, the Catoctin range, on the eastern side, which extends south from the southwestern portion of Adams County, Pa., and crosses the Potomac at Point of Rocks, and thence extends south a little west of Leesburg, Va. The Blue Ridge and the Catoctin Ridge are the eastern and western sides of the mountain uplifts of which South Mountain, Pennsylvania, is the northern terminus. Prof. H. D. Rogers describes South Mountain as composed almost entirely of rocks of the "Primal series." He says:

> It is doubtful if the true gneissic rocks anywhere reach the surface within its borders, and only in one or two localities have even the lowest members of these Auroral limestones been met with covering the upper Primal slates. Even of intrusive igneous rocks it embraces a singularly small amount, those met with being chiefly greenstone and trap rock.[2]

On the geologic map accompanying this report the South Mountain area is indicated as unaltered Primal rock. He regarded the quartzite of South Mountain as the Primal quartzite, and the shales as the Primal

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[1] Second Geol. Surv. Penn., A Summary Description of the Geology of Penn., Vol. I, 1892, p. 142.
[2] The Geology of Penn., Vol. I, 1858, p. 203.

slates, and mentions that at one locality, Pine Grove Furnace, there occurs in the middle of this range of slate a narrow band of limestone, marking the position of the axis or keel of the trough into which the formations have been folded.[1] He speaks of a band of altered siliceous rock, and south of it a zone of green altered slate charged with epidote; overlying this again, another belt of a more siliceous altered slate.[2] In speaking of the lower Primal slates beneath the quartzites, he says:

> These lower Primal slates are highly indurated, and even decidedly crystalline, containing in some of their layers segregated specks and even half-formed geodes of epidote and other minerals. They bear a strong general resemblance to the half crystallized, older Primal slates just south of Spring Mill. * * * Near the tunnel at the northwest side of Jacks Mountain there is a hard epidote rock, and not far from it highly altered greenish slate—a rock found in several other localities farther west, and containing layers of grey slate spotted with epidote. Farther west occurs epidote with asbestos.[3]

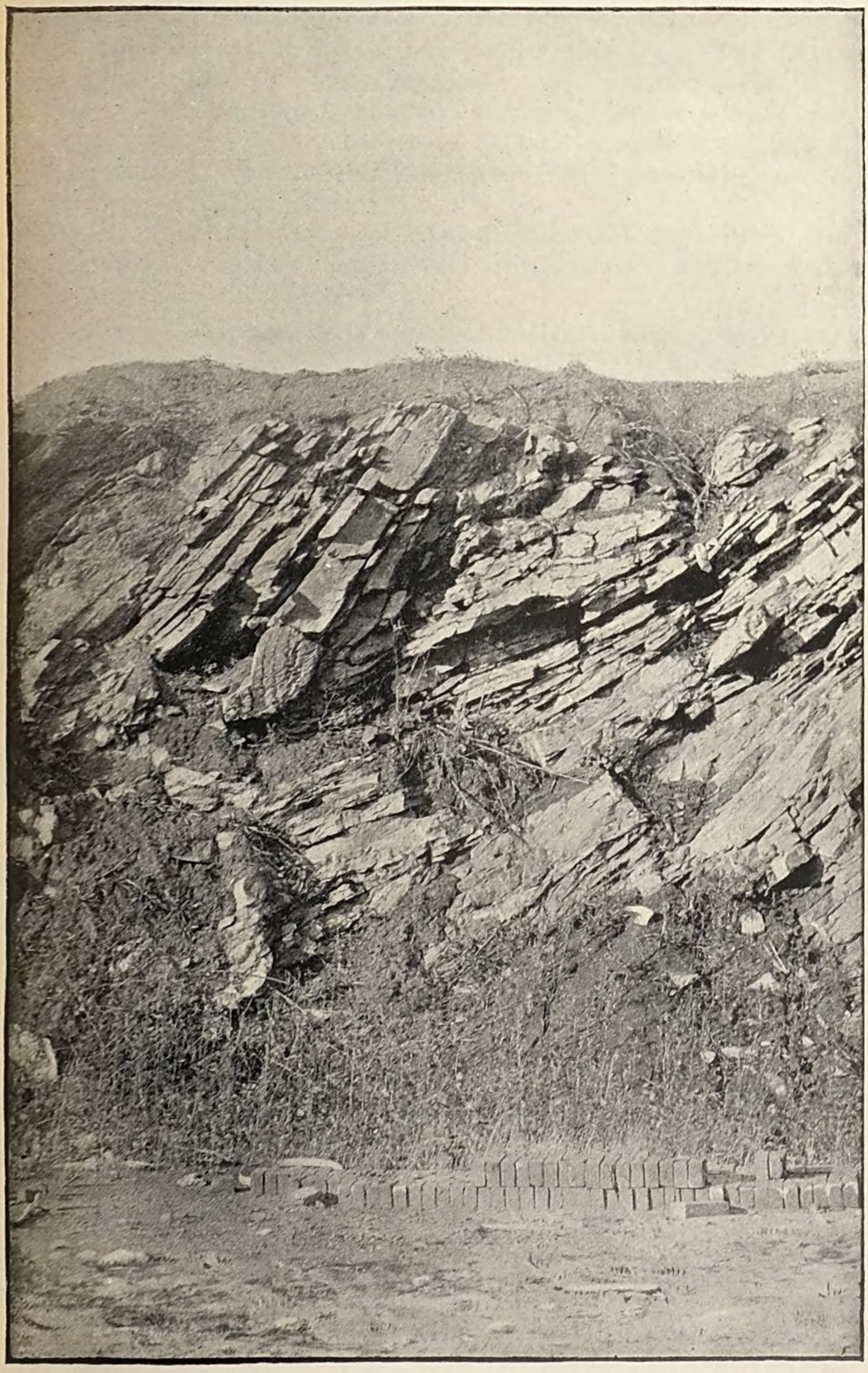
Of the metamorphic strata of Pennsylvania, Prof. H. D. Rogers says that before the geological surveys of Pennsylvania and Virginia were organized the ancient and more altered strata between the summit of the Atlantic Slope, in the Blue Ridge and South Mountain, and its base at the margin of tide water were regarded and designated alike as primary rocks, and were supposed to constitute but one group—the oldest known to geologists:

> Early, however, in the course of those surveys, it came to light that by far the larger portion of the rocky masses of at least the middle and northwestern tracks, including much of the Blue Ridge and of the Green Mountains, were of a different type and age from the oldest metamorphic or true gneissic system. The evidence in support of this conclusion was, first, an obvious and very general difference in the composition of the two sets of strata; secondly, a marked difference in their conditions of metamorphism; and thirdly, and more especially, a striking contrast in the direction and manner of their uplift.[4]

He regarded the sandstone with *Scolithus linearis* as at the base of the Paleozoic series, and believed that the Primal slates beneath the sandstone, and in intimate alternation with it, did not possess a vestige of organic life. He then states that there are now two main horizons subdividing the more or less metamorphic strata of the Atlantic Slope into three systems of groups—the one, a physical break or interruption in the original deposition of the masses; the other, a life limit or plane denoting the first advent, so far as yet discovered, of organic beings. These two planes are not coincident, but include between them a thick group of sedimentary rocks, separated from the lower physically, from the other paleontologically. To the most ancient or lowest group he gave the name of the Gneissic series; to the great middle group, less crystalline than the gneissic, and yet destitute of fossils, the descriptive terms Semimetamorphic or Azoic; and to the third or uppermost system—the entire succession of the American Appalachian strata, from the Primal to the true coal rocks—the term Paleozoic. As summed up, this classification is: The Hypozoic rocks, or those underneath any life-bearing strata; Azoic, or those destitute of any discovered relics of life;

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[1] Loc. cit., p. 203. [2] Loc. cit., p. 205. [3] Loc. cit., p. 207. [4] Loc. cit., pp. 62, 63.



SYNCLINAL FOLD IN THE THIN-BEDDED LOWER CAMBRIAN LIMESTONES, AS SEEN IN A QUARRY IN THE SUBURBS OF YORK, PENNSYLVANIA.

and Paleozoic, or those entombing the remains of the earth's most ancient forms of living beings.[1]

It is evident from Professor Rogers's definition of the Azoic group that it included what we now recognize as the Lower Cambrian sedimentary strata beneath the Scolithus quartzite, and also an extended series of altered rocks that form the nucleus of the Blue Ridge and which are now included in the Algonkian of the classification of the United States Geological Survey.

The conclusions of the geologists of the Second Geological Survey of Pennsylvania are that there are two groups of rocks forming South Mountain. Dr. Frazer states:

> Hence, it is made apparent that the great South Mountain chain is composed essentially of two groups of rocks, the lower (and along this line the northwestern) consisting of various modifications of the quartz conglomerate above spoken of, and in which quartzite occurs in various forms. The upper and southeasterly group is felsitic in character, but contains also large beds of hydro-mica and chlorite schists intersected by veins of milk quartz, while the orthofelsite itself presents every variety of appearance, from a sandy and earthy slate in which the crystals of orthoclase are very much decomposed—indeed are sometimes almost clay—through the jasper-like variety to the massive and coarsely porphyritic structure in which it is suited to be used as an ornamental building stone.[2]

In a paper entitled "The Lake Superior Copper Rocks in Pennsylvania,"[3] Mr. J. F. Blandy gives a figure of an ideal section of South Mountain in which the sandstones pass beneath the epidote traps, etc. In the discussion following the reading of the paper (at a subsequent session) Dr. Frazer states that "the Potsdam or Primal Formation of Rogers is wanting all over that county, with the exception perhaps of detached patches on the northwest flank of the South Mountain chain." He reaffirms his view that the rocks of South Mountain may be divided into two great series: "A western (underlying), of which the characteristic strata are composed of quartzite and of arenaceous schist containing quartz pebbles (Mountain Creek rock), and the eastern (overlying), of hydro-mica and chlorite schists, and orthofelsite, both porphyritic and unporphyritic."[4] At a later date Dr. Frazer[5] explained the structure of the copper belt of this region by the presence of a series of faults, which have brought blocks of strata in different relations to one another, and thus repeated the sections:

> But the great width of the South Mountain chain along the Chambersburg turnpike, the abrupt protrusion to the east of the eastern part of the chain, south of the Chambersburg-Gettysburg turnpike, and of the western part of the chain to the west, north of this line, and the contacts of the Paleozoic and Eozoic rocks of very different horizons in the middle portions of the chain, all point to the existence of extensive longitudinal and transverse faults in these measures.

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[1] Geology of Pennsylvania, Vol. I, 1858, pp. 63, 64.

[2] Second Geol. Surv. Penn., Report of Progress in the counties of York, Adams, Cumberland, and Franklin for 1875 (1877), p. 285.

[3] Trans. Amer. Inst. Mining Eng., Vol. VII, 1879, p. 332.

[4] Loc. cit., p. 338.

[5] An Hypothesis of the Structure of the Copper Belt of the South Mountain: Trans. Amer. Inst. Mining Eng., Vol. XII, 1884, pp. 82–85.

Professor Lesley says:

The northwestern (Mount Holly) ridge is made by several thousand feet of the lower quartzite and quartz conglomerate beds. The southeastern (Adams County) ridges are made by several thousand feet of an overlying feldspathic, micaceous, and chlorite series, intersected by veins of milky quartz.

These two series, or great subdivisions, seem at some places to graduate into each other, as if they were the earlier and later deposits of one age. In other places (as in the Greenwood section No. 10) they seem distinct, the passage from the lower quartzite series to the higher porphyritic (orthofelsite) series being abrupt, with even an apparent difference of strike in some of the outcrops along the line of section.[1]

In a footnote he calls attention to the resemblance of the feldspathic rocks of the upper group of rocks to the kaolin slate beds in the Virginia Blue Ridge section at Balcony Falls, as described by Fontaine.[2] He regards the lower, or quartzite and conglomerate slate, series as certainly immensely thick, and says that a total thickness of 14,000 feet is suggested along Dr. Frazer's cross-section No. 10. Other sections across the mountains toward Mount Holly Springs exhibit a certain minimum thickness of 5,000 feet, and a possible maximum thickness of 10,000 feet and 12,000 feet, of quartzite series.[3] It is further stated that the thickness of the overlying feldspathic felsite series, along the Mount Holly cross-section No. 8 of Dr. Frazer's, exceeds 6,000 feet, as shown in the broad syncline:

The Mountain Creek rock subdivision of the lower series is characterized by scattered pebbles and by occasional solid beds of conglomerate. Dr. Frazer gives it various names, descriptive of its varieties: "Schist conglomerate," "green schist with quartz pebbles" (some of them of transparent quartz, others of amethyst-colored quartz), these last two varieties of conglomerate marking a transition to the Upper series. It is evident that the great Lower series, if indeed it be separable from the Upper, has the lowest set of beds which are almost wholly of metamorphosed sand, quartzite; then higher sets of clay, sand, and pebble beds, metamorphosed into quartzose slates, shales, schists, and pebble rock.

The still higher and more or less magnesian slates, hard shales, crystalline schists with scattered pebbles, conglomerate beds, and porphyritic beds, make an indefinite, but recognizable Upper system, in which occur also true quartzite beds, like those at the bottom of the Lower series. Occasional fragments of diorite trap appear on the surface which may indicate interbedded volcanic rocks, or possibly very small dikes. The whole may have been capped by the Hellam (Chiques rock) quartzite, fragments of which are so abundant on the lower southeast slope of the South Mountain mass. It is hard to avoid the inference that our South Mountain rocks represent the Huronian section of Murray and Logan. It is impossible not to compare them also with the great quartzite masses, the roofing slates, etc., of Walcott's Upper, Middle, and Lower Cambrian system.[4]

Professor Lesley regards the conglomerate beds as fixed horizons in the series, and states that they may be exaggerated in number on account of repetition in anticlinal and synclinal folds.[5]

It will be observed from the preceding views of Professor Lesley's

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[1] Second Geol. Surv. Penn., A Summary Description of the Geology of Penn., Vol. I, 1892, pp. 144, 145.

[2] Loc. cit., p. 144.

[3] Loc. cit., p. 145.

[4] Loc. cit., pp. 147, 148.

[5] Loc. cit., p. 150.

that he was in doubt as to whether the South Mountain rocks were of Huronian or Lower Cambrian age.

In speaking of his study of the South Mountain, west of the Susquehanna and stretching southward to the Potomac, Dr. T. Sterry Hunt says of the pre-Paleozoic rocks:

> In this portion, so far as I am aware, it shows no Laurentian north of the Potomac, but consists of Montalban and Huronian, the latter constituting the strata at Harpers Ferry and for some miles to the eastward along the Baltimore and Ohio Railroad. In the southern part of Pennsylvania to the west of Gettysburg this mountainous belt, rising between the Mesozoic on the east and the great limestone valley on the west, presents an immense development of a peculiar type of crystalline rocks which I detected there last year and which has a considerable geologic importance. It is a bedded petrosilex, grayish, reddish, or purple in color, sometimes granular, but more often jasper-like in texture, and frequently porphyritic from the presence of small crystals of orthoclase-feldspar or of glassy quartz. There is here found a great breadth of this rock distinctly bedded, presenting different varieties, and alternating with diorite, or diabasic, epidotic, and chloritic rocks, with argillites, in which are sometimes included thin beds of petrosilex—the strata generally dipping at high angles to the southeast. These petrosilex beds with their accompanying rocks are identical with those which I have described as occurring on the eastern coast of New England, and farther northward along the Bay of Fundy in New Brunswick. They are well seen at Lyon, Saugus, and Marblehead in Massachusetts, and also on the shores of the Passamaquoddy Bay, where they are interstratified, as in the South Mountain, with rocks having the character of the Huronian series; to which great division I have provisionally referred these bedded petrosilex rocks, with the suggestion that they probably occupy a position near the base of the series.[1]

After making the statement that the crystalline rocks of the Green Mountain series belong to a more ancient system, which underlies unconformably the crystalline Cambrian sediments of the Quebec group, Dr. Hunt states that in a letter received by him from Prof. William B. Rogers, dated June 8, 1877, there are statements to the same effect in regard to similar strata in Virginia, as follows:

> The sections which I had the pleasure of showing you lately, illustrating the position of the Lower Cambrian beds (our Primal conglomerate, etc.) in their contact with the crystalline and metamorphic rocks of the Blue Ridge in Virginia, form the part of a series embracing the results of some forty transverse explorations made during and since the Virginia geological survey at nearly equal distances across the chain from Harpers Ferry to the North Carolina line. In many of these sections the unconformity of the Cambrian upon and against crystalline and metamorphic rocks is unmistakable and conspicuous, the lower members of the Primal being seen to rest on the slope of the ridge, with northwest undulating dips, on the edges of the steeply southeastward-dipping older rocks. In other cases the Primal beds thrown into southeast dips in the hills which flank the Blue Ridge are made to underlie, with more or less approximation to conformity, the older rocks forming the central mass of the mountain. But even in these instances it is, I think, not difficult to discern the true relations of the strata.[2]

Dr. Hunt follows this quotation with the statement that the crystalline rocks which are the prolongation of the Blue Ridge into southern Pennsylvania have already been described as Huronian by him.

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[1] Proc. Amer. Assoc. Adv. Sci., Buffalo, N. Y., 1876, published in 1877, p. 211.

[2] Second Geol. Surv. Penn., Special Report on the Trap Dikes and Azoic Rocks of Southeastern Pennsylvania, Part I, 1878, pp. 198, 199.

When I began the investigation to ascertain by stratigraphic and paleontologic evidence the geologic age of the South Mountain quartzite and the associated schists and shales, I soon discovered that there was little prospect of finding the true geologic succession in the northern portion of the mountain in Cumberland and York counties, owing to the folding of the strata, and also to the fact that there were a number of westward thrusts of lower upon higher beds, and that, as a result of this, the central core of the Blue Ridge has been broken and thrust over on the Lower Cambrian beds, and also, in places, rests apparently conformably upon the latter, all having an eastward dip. The discovery of Olenellus with *Hyolithes communis* in the massive quartzite series in the Mount Holly Ridge, just above Mount Holly Springs, in Cumberland County, proves that the great western mass of quartzite of South Mountain, with the interbedded shales, slates, and conglomerates, are of Lower Cambrian age, but it does not throw any light upon the geologic age of the orthofelsite series of Frazer and the epidote rocks of Rogers. In company with Mr. Arthur Keith, of the United States Geological Survey, who had mapped the Harpers Ferry sheet, an examination was made across the ridges from Mechanicstown, Md., to Monterey, and westward to Pikesville, in Franklin County, Pa. On entering the gorge a little west of Mechanicstown, on the line of the Western Maryland Railroad, an extended series of shales and slates was passed, all having a very high dip to the south-east. About 2 miles from Mechanicstown massive quartzites were met having a high dip to the east, and higher up in the gorge there was a repetition of the slates found east of the quartzites. This section indicates, from the dips of the quartzites, a syncline resting on a considerable thickness of slates and shales. A series of sections, by Mr. Keith, of the western or Blue ridge, extending from a point 11 miles south of Mechanicstown to Harpers Ferry, shows that this same synclinal structure prevails all along the ridge, and that a synclinal fold of massive sandstone forms the summit of the ridge, below which a series of shales rests unconformably upon the subjacent crystalline rocks.[1] The synclinal structure is also shown for the quartzites of the eastern or Catoctin ridge.

From a point 2½ miles west of Mechanicstown to Monterey the road led across the epidote-schists of the central nucleus of the range, which is now a mountain valley between the Catoctin and the Blue ridges. The schists extended to a point one-fourth to one-half a mile beyond the Blue Ridge station, on the Western Maryland Railroad. Fragments of a rhyolitic-like porphyritic rock were also seen, which probably represent the "bedded petrosilex" of Dr. Hunt, as shown 2 miles south of the Monterey road, near Foxville, Md.[2] Along the road

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[1] The Structure of the Blue Ridgen ear Harpers Ferry: Bull. Geol. Soc., Amer., Vol. II, 1891, Pls. IV, and V.

[2] Dr. George H. Williams made a detailed study of the volcanic rocks of South Mountain, in Pennsylvania and Maryland. He gives an historic sketch of the various views that prevail as to the character,

beyond Pen Mar toward Pikesville, there was an apparent repetition of the section on the eastern side of the ridge, near Mechanicstown. Subsequently an examination was made of the section from Monterey, Franklin County, Pa., to the valley, on the line of the Waynesboro turnpike. Just west of Monterey a massive quartzite forms a plateau, upon which the Monterey hotel is situated. The dip of the quartzite is slightly to the northwest. A short distance beyond the tollgate the dip to the northwest increases, and a series of sandy and argillaceous shales succeeds the quartzite. Following down the turnpike toward Waynesboro, and near the foot of the ridge, these shales were found to pass beneath a light-colored, hard, compact quartzite dipping northwest, in which numerous remains of *Scolithus linearis* occur. I also found, upon breaking the white quartzite, many fragments of Olenellus, showing parts of the head and thoracic segments. In calcareo-arenaceous layers, just beneath the quartzite, fragments of Olenellus occur associated with specimens of *Camarella minor*. A series of more or less sandy shales next appears, resting upon the Scolithus quartzite and having a northwesterly dip toward the valley. Along the foot of the ridge low hills of shale appear, capped with thin-bedded calcareous quartzite or sandstone. In the latter, *Camarella minor*, *Hyolithes communis*, and fragments of Olenellus were abundant. A little west of the slate hills the limestones of the valley appear. In the limestone a little east of the road, on the East Branch of Little Antie-

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of the rocks of South Mountain, followed by a description of the eruptives, as determined by him. He says:

"The cause of the prevailing misconception regarding the volcanic rocks of South Mountain is not difficult to find. Their accompanying accumulations of tuff beds and breccias, and the fact that they are generally cleaved parallel to the great structure planes of the mountain, have all been readily interpreted as indications of stratification and conformity. The cleavage dip in the sandstone has often been mistaken for bedding, while the thin jointing and slaty structure of the lavas, though a secondary feature, have seemed, to geologists not very familiar with recent volcanic rocks, sufficient proofs of sedimentary origin.

"In spite of great age and some alteration, however, the volcanic rocks of South Mountain have preserved all the essential characteristics of our recent rhyolites and basalts in such perfection that the proofs of their real nature are, to the student of comparative petrography, overwhelming, while to all who will candidly examine them they must be at least convincing."

In relation to the age of the South Mountain volcanics he says: "The age of the South Mountain volcanics and their relations to the sandstone in which Mr. Walcott has recently identified the Lower Cambrian fauna, are points of great interest. The hypothesis of the Pennsylvania geologists that the greenstones and felsites lie above the sandstone is evidently incorrect. It may, however, be regarded as an open question whether the volcanic rocks represent a much older horizon, which was already eroded before the sandstone was deposited, or whether they were, in part at least, contemporaneous with the sandstones.

"The entire absence of sandstone as inclusions in the lavas, as well as in all the accumulations of pyroclastic material; the observations of Keith, Geiger, and Walcott, that the sandstone lies flat or in synclinals; and the sections made by Miss Bascom across Monterey Peak, Pine Mountain, Jack's Mountain, and Haycock, near Monterey, all indicate that the sandstone is altogether above the volcanic rocks, and that it has been only sporadically left by erosion on the east side of the mountain in Pennsylvania. In Maryland the volcanic rocks are flanked both on the east and west by sandstone. No alternations of relatively thin beds of sandstone and lava have thus far been observed. The contacts of the sandstone above the porphyry on the old tapeworm railroad southwest of Maria's Furnace, and above the greenstone in the Jack's Mountain railroad tunnel are both admirable exposures, but both seem to be thrust planes and are not contacts of original deposition.

"The South Mountain volcanic rocks therefore become, not merely in their petrographical character and richness in metallic copper, but also in their stratigraphical position, comparable with the Keewenawan or Nipigon series of Lake Superior."—Am. Jour. Sci., 3d ser., Vol. XLIV, 1892, pp. 482–496.

tam Creek, and about 3 miles east of Waynesboro, Kutorgina n. sp. and fragments of the head and thoracic segments of Olenellus were found.

If reference is now made to the York County section, it will be seen that the upper portion of the Monterey section is essentially a repeti tion of it, from the Scolithus quartzite to the limestones of the valley. The same fossiliferous Scolithus quartzite passes beneath the shales, in which are interbedded calcareous quartzites carrying the Olenellus fauna; these pass beneath the limestones of the valley in York County in which the Olenellus fauna occurs. In the Monterey section, however, there is a series of shales beneath the Scolithus quartzite, that rests upon a massive quartzite forming the summit of the Blue Ridge south of Monterey.

The Blue Ridge was followed south into Maryland and crossed at several points before reaching Harpers Ferry. All of the sections show the synclinal structure of the shales and quartzites as represented by Messrs. Geiger and Keith in their paper on the structure of the Blue Ridge near Harpers Ferry.[1] South of Keedysville, Washington County, Md., the quartzite capping the slate hills west of the main ridge was observed to pass conformably beneath the limestone at Eakles Mills, and *Hyolithes communis* and fragments of Olenellus were found in the calcareous quartzite. The stratigraphic structure south of the Monterey section is complicated at and near Harpers Ferry by the massive quartzite's forming a syncline and by its being thrust to the westward over the more recent shales, slates, and limestones. The structure is still more obscured by the fact that the hills of shale (capped by the Olenellus quartzite) are thrust, on the line of a fault, over on limestones. which, in an unbroken section, rests upon the quartzites.

It was this primary folding, and subsequent westward thrusting on the line of two or more faults, of the older upon the more recent strata, at and to the north and south of Harpers Ferry, that led Messrs. Geiger and Keith to consider that the lower quartzites rested conformably upon the limestones and were of Silurian age.[2]

Returning to the study of South Mountain with the information gained between the Potomac and the line of the Chambersburg and Gettysburg pike, in Pennsylvania, and studying Dr. Frazer's sections (Nos. 7, 8, 9, 10, 11, and 13)[3], and also reading the descriptions of them, as well as Professor Lesley's description of South Mountain (as contained in Vol. I of his final report), one sees that these investigators have misinterpreted the true geologic structure of the mountain and the relations of the rocks composing it. Professor Lesley states that a massive fault must run along the foot of the mountain, along the low drift-filled

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[1] Bull. Geol. Soc. Amer., Vol. II, 1891, Pls. IV and V.

[2] Structure of the Blue Ridge near Harpers Ferry, Va.: Bull. Geol. Soc. Amer., Vol. II, 1891, pp. 155–163, Pls. IV and V.

[3] Second Geog. Surv. Penn., Report of Progress on the Counties of York, Adams, Cumberland, and Franklin for 1875–1877.

valley of Yellow Breeches Creek; and in this I think he is correct, as the Olenellus fauna of the Scolithus quartzite zone occurs but a short distance east of the foot of the mountain in a synclinal fold, at Mount Holly Springs. The great error, however, is the view that the "orthofelsite" series is superior to the conglomerate, quartzites, and schists, which they referred to the lower series, placing the "orthofelsite" series above the quartzite series. The Monterey section shows that the epidotic schists are inferior to the quartzites; and a section west of Wolfsville, Md., shows that the petrosilex or "rhyolitic-like" eruptive occupies a similar position. This type of section is repeated many times, both on the Catoctin and Blue Ridge sides, from the Maryland line to the Potomac, and south through Virginia.

Professor Rogers, and also Professor Lesley, referred the offsets of the ranges of hills of South Mountain, as shown in Franklin County, and also on the north end of South Mountain, to the terminations of successive folds of the rocks forming the mountain. My impression is that these offsets, and also the complicated structure of the mountain, arise partly from folding, but more largely from the westward thrusts of masses of strata along the lines of fault of a low hade. This westward thrusting on the fault plane, complicated by previous folding of the strata, leaves masses of the subjacent, pre-Paleozoic rocks resting, in various places, on different members of the Lower Cambrian series, and also appears to interbed the quartzites and schists of the Cambrian in the schists, eruptives, etc., of the Algonkian.[1]

The key to the succession of the lower sedimentary rocks of Maryland and Pennsylyania is contained in the Balcony Falls section of Virginia, although it can be determined by a study of the section at Monterey and to the south along the Blue Ridge, toward Harpers Ferry.

In a letter from Professor Lesley, dated February 22, 1891, he asks:

> Is it possible that there should be agreement between the Balcony Falls section of Virginia and the Mount Holly Spring section, 300 miles apart?

He says, further, after commenting upon the possible relations between the Balcony Falls section and that at South Mountain, in speaking of the strata of the Balcony Falls section:

> But what is 2,000 or 2,500 feet to 10,000 or 20,000 feet of quartzites and slates, making (apparently, not certainly) the South Mountains? We are still in the dark about super and sub positions; about absence or presence of overturn rolls, etc. I am only greatly impressed with the broad fact that we seem to have the Huronian mass rising to view in the South Mountains of the Atlantic States.

I think that the views of Messrs. Frazer and Lesley, that such great thicknesses of strata occur in South Mountain, arise from the fact that

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[1] From the finding of the fragments of eruptive rocks in the conglomerates at the base of the quartzite series, and from the numerous synclines showing that the epidotic rocks and also certain rhyolitic eruptives are beneath the quartzite series, I refer the similar rocks of South Mountain to a pre-Paleozoic age; and, as they are not of the characters of the Laurentian crystalline complex, I would refer them to the Algonkian, but not correlate them with the Huronian or with any known division of that group of rocks. Am. Jour. Sci., 3d ser., Vol. XLIV, 1894, p. 480.

these "great thicknesses" are but repetitions of both the Cambrian and pre-Cambrian strata as a result of folding and overthrust faulting, and from failure to differentiate the cleaved schistose eruptives of the Algonkian from the bedded sedimentaries of the Lower Paleozoic.

LANCASTER, BERKS, AND LEHIGH COUNTIES.

It has been stated that *Hyolithes communis* and fragments of Olenellus were recognized in the material collected from limestones in Lancaster County, on the east side of the Susquehanna River,[1] and that from the closely related stratigraphic arrangement of the rocks of Lancaster County it is probable that all the Lancaster limestones will fall within the Cambrian, unless it be that some portion of the upper series may pass into the Ordovician. This generalization will also apply to the limestone in the adjoining counties of Berks and Chester, and, in fact, to the entire extension of this series northeastward to the Delaware. All of the quartzites that have been referred to the Potsdam will necessarily fall into the Lower Cambrian, as they are beneath the limestones.[2]

Prof. A. Wanner, of York, Pa., accompanied me in the examination of the limestones about the city of Lancaster. His familiarity with the positions of the quarries and natural outcrops enabled us to make a rapid examination of the limestones along Conestoga Creek, and, although no fossils were found, I saw no reason to think that the limestones were not of Cambrian age. We next proceeded to the eastern side of the county, where the southern division of the limestone passes into Chester County. An examination was made of the lower quartzites and the superjacent limestones at Gap, Limeville, and toward Compassville. A few Scolithus borings were noted in the quartzites northeast of Gap, and fragments of Olenellus and specimens of Obolella were found in sandy layers embedded in a shale 1 mile north-northeast of Gap. The section from the top downward, from a point a little east of Gap northwest, is:

5. Massive-bedded, light-colored limestone, with partings and small, interbedded, flattened nodules of mica-schist.

4. Narrow belt of hydromica-schist, with thin layers of hard calcareous sandstone containing Obolella and fragments of Olenellus.

3. Massive beds of bluish-black and nearly white limestone, extensively quarried at Limeville.

2. Narrow belt of shale altered to a hydromica-schist.

1. Quartzite, in the hill northeast of Gap.

We next visited the extensive quarries at Bellemont, on the main line of the Pennsylvania Railroad, 4 miles west of Gap. In the quarries the conglomerate limestone, so characteristic of the Cambrian at Stoners Station, in York County, are beautifully exposed, and numer-

[1] Notes on the Cambrian Rocks of Pennsylvania and Maryland from the Susquehanna to the Potomac: Am. Jour. Sci., 3d ser., Vol. XLIV (Dec., 1892), p. 474.

[2] Loc. cit., p. 475.



CLIFF OF MASSIVE-BEDDED LOWER CAMBRIAN LIMESTONES AT THE QUARRIES ON THE LINE OF THE PENNSYLVANIA RAILROAD AT BELLEMONTE, LANCASTER COUNTY, PENNSYLVANIA.

Bluish-black at base, white above, and capped by thinner layers of a dark, arenaceous limestone.

ous photographs were taken of the conglomerate beds, showing their positions between the evenly bedded limestones. The limestones and conglomerates belong to No. 3 of the Gap section, and are overlain by a belt of shale in which massive beds of a fine limestone conglomerate occur. No time was given to searching for fossils.

Pl. VI illustrates the massive-bedded limestone beneath the conglomerate limestone. This bed is very persistent, and is the source of most of the limestone quarried for the limekilns of this section. Pl. VII is a view taken about one-fourth of a mile to the eastward, where the massive bed of limestone is capped by the conglomerate band, a thin bed of dark, shaly limestone intervening between them. Higher up in the section, about one-fourth of a mile north, the upper massive limestone is exposed in some extensive quarries. This is more siliceous than the beds below, and it breaks up into angular fragments, so as to give the appearance, when viewed at a little distance, of a cliff of quartzite or crystalline rock (Pl. VIII). In the immediate vicinity of the Bellemont quarries one of the characteristic limekilns of a generation ago is in a fair state of preservation. As these are rapidly passing away, a photograph of this kiln was taken, and it is reproduced in Pl. IX.

The discovery of the Olenellus fauna in the limestone in the eastern portion of Lancaster County, north of Gap, taken in connection with the eastern section of York County, compels the reference of the so-called Potsdam rocks of Chester County, with their superjacent limestones, to the Cambrian. As mentioned previously (p. 28), it is quite probable that the limestones toward the Triassic area, in the northern portion of Lancaster County, may be of Ordovician age, but this can be proved only by the discovery of the fauna.

NORTHERN BELT OF LIMESTONE.

As shown by the geologic map of Pennsylvania (1884), the northern belt of limestone enters the State in Franklin County, and then turns to the northeast in Cumberland County, crosses the Susquehanna at Harrisburg, and extends on eastward across Dauphin, Lebanon, Berks, Lehigh, and Northampton counties, to the Delaware River. The Olenellus fauna was found in the quartzites of South Mountain in Adams County, as well as in the lower portions of the limestone in Franklin County.[1] From this, and the fact that the lower portions of these limestones and the superjacent quartzites or sandstones were known to be of Lower Cambrian age in their extension into New Jersey, I began the examination of them in the vicinity of Reading, where their relations to the Reading sandstone are well defined. The *Scolithus linearis* occurs abundantly in the quartzites of Penn Mountain, east of Reading, and on the south side of Neversink Mountain, across the Schuylkill. In the upper layers of the sandstone or quartzite I obtained

[1] Loc. cit., p. 478.

Hyolithellus micans and fragments of a species of Olenellus. This locality is about one-half mile above Klappenthal Station, on the Philadelphia and Reading Railroad, and the terminal station of the electric road running out of Reading over the Neversink Mountain. West of the first railroad cut above the station, between the cut and the stone crusher, thinner beds of quartzite are met with that carry fossils. The quartzites are more or less contorted and folded, but their stratigraphic relations to the main quartzites of the mountain and to the adjoining limestones are readily determined. No fossils were observed in the limestones.

The sections in the vicinity of Allentown and Bethlehem were examined and found to be essentially the same as at Reading, the quartzites passing beneath the limestone. In the quarries at Catasauqua, 4 miles north of Allentown, I noted the occurrence of a large Pleurotomaria, of the type of *Pleurotomaria canadensis*, of the Calciferous horizon in New York and Canada. In the report of the Second Pennsylvania Geological Survey of Lehigh and Northampton counties the localities of fossils are all represented as being on the northern side of the outcrop of limestone, in the strata that dip to the northward beneath the superjacent shales. The Trenton horizon is represented as in the limestone immediately beneath the shales (called "Hudson"); and lower down, in massive limestone, species of Maclurea or Eomphalus, which indicate the Chazy horizon, have been found. This distribution of faunas is the same as in Franklin County, where the Lower Cambrian fauna occurs at the base of the limestone, near the quartzites, and the Trenton fauna at the summit, near the base of the superjacent shales.

The limestones were examined in the vicinity of Easton, along Bushkill Creek and the shores of the Delaware River. No fossils were found, with the exception of a species of Cryptozoan; but from the similarity of the limestone to that of the lower portion of the series near Allentown, Reading, and in Lancaster County, it is quite probable that they represent the Lower Cambrian portion of the section. North of Easton 5 or 6 miles, in the vicinity of Churchville, fossils that indicate the Trenton horizon were discovered by the Pennsylvania Survey. I think it is only a matter of detailed search and patience to discover localities of fossils, both in quartzites and limestones, throughout this belt, from where it enters the State from Maryland to where it crosses the Delaware into New Jersey.

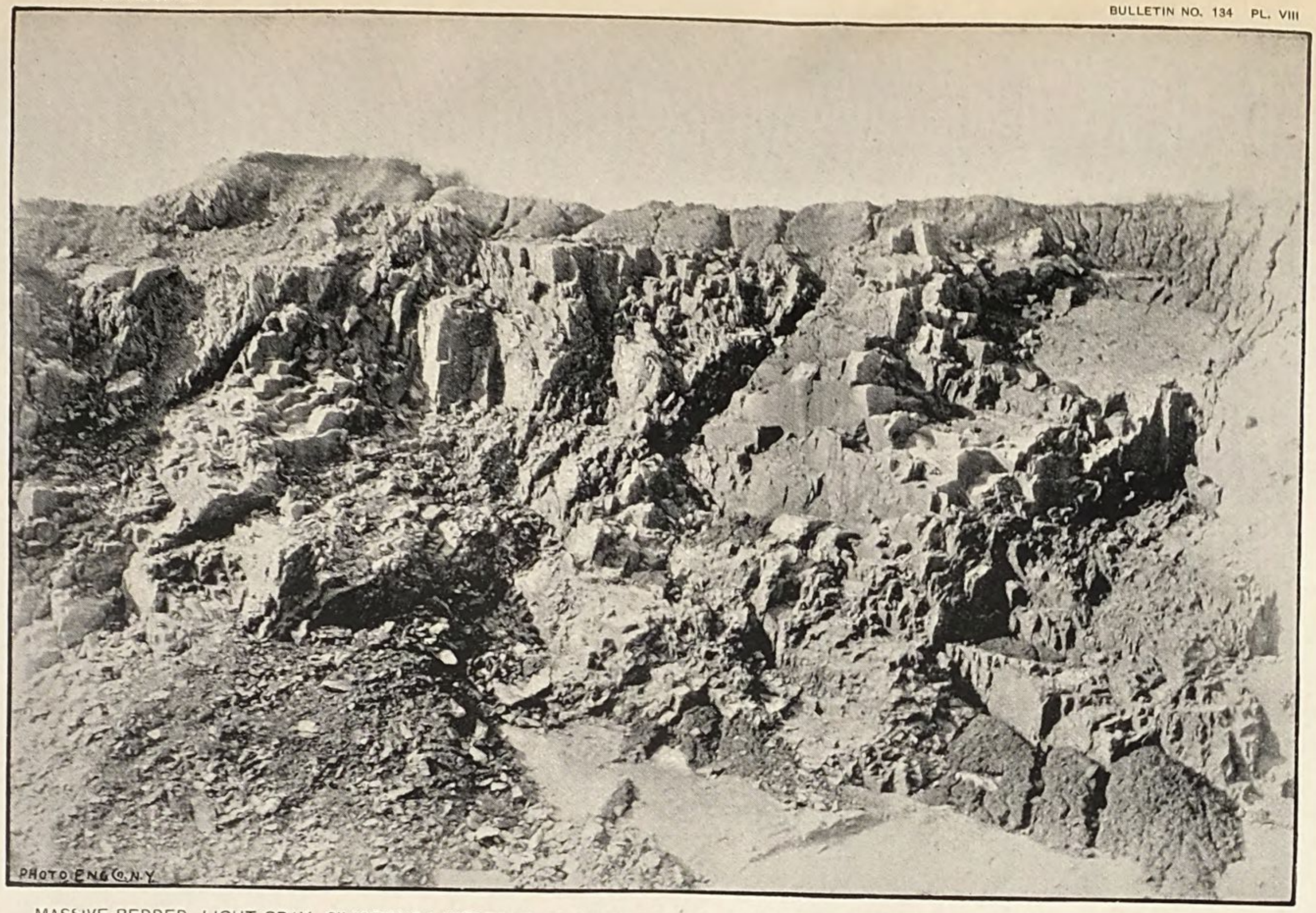
If we follow the line of the strike of the limestones across the Delaware into New Jersey, the same type of section is found to extend northeasterly across that State and into Orange County, N. Y. At Hardistonville, Sussex County, N. J., Dr. Beecher discovered the Olenellus fauna in the blue limestones resting on the basal quartzite.[1] The fossils are found on the southeastern side of the limestone belt, and on the northwestern side the limestones dip beneath the shales, as

[1] Geol. Surv. New Jersey, Ann. Rept. State Geologist, 1890, pp. 31, 43, 49.



LOWER CAMBRIAN LIMESTONE EXPOSED IN QUARRIES AT BELLEMONTE, LANCASTER COUNTY, PENNSYLVANIA, ON THE LINE OF THE PENNSYLVANIA RAILROAD, A SHORT DISTANCE EAST OF PL. VI.

The massive limestones are here capped by a band of limestone conglomerate that rests on the thin-bedded limestone shown in top of quarry, Pl. VI.



MASSIVE-BEDDED, LIGHT-GRAY, SILICEOUS LIMESTONE, IN QUARRIES ONE-FOURTH MILE NORTH OF PENNSYLVANIA RAILROAD TRACKS, BELLEMONTE, LANCASTER COUNTY, PENNSYLVANIA.

The limestone breaks into angular fragments on the lines of the bedding and cleavage planes.

in the Pennsylvania section. In the geological report of New Jersey for 1868, pages 131 and 132, numerous localities of the fossiliferous Trenton limestone are described, and a section is given showing the limestone passing beneath the shales to the westward.

In the summer of 1894 I found at a point 4 miles northeast of Newfoundland, N. J., fragments of Olenellus in the limestone resting on a bedded quartzite which was in contact with the pre-Cambrian gneiss. The Cambrian rocks at this point are represented by a lower quartzite 10 or 15 feet in thickness, a massive-bedded, siliceous limestone that may be 200 feet thick, and a series of shales of inconsiderable thickness that pass beneath the Silurian (?) conglomerate of Kanouse Mountain.[1]

CORRELATION.

Reference has already been made to the similarity, noted by Professor Lesley, between the rocks of South Mountain and those described by Professor Fontaine in the Balcony Falls section of Virginia. The latter section, as described by Mr. H. D. Campbell, in 1885, is as follows, from the base up:

Section at Balcony Falls, Va.

	Feet.
8. Scolithus sandstone	350
7. Slates	120
6. Sandstone	90
5. Slates	700
4. Hard sandstone	150
3. Slates	500
2. Sandstone	360
1. Conglomerate	120
Total	2,390

He further states that, away from the river some distance, there are about 600 feet more of sandstone and friable slate before the limit of the Potsdam formation is reached.[2]

The sandstones and slates of the section, with the exception of No. 8 (the Scolithus sandstone), and the superjacent shales, are all more or less feldspathic. The Scolithus sandstone and the beds just above it are known to be of Lower Cambrian age,[3] and Cambrian fossils were found near the summit of the superjacent shales beneath the limestones.

Prof. William B. Rogers traced, as he thought, the Primal sandstones and slates of the Balcony Falls section across Virginia to Harpers Ferry, where they crossed the Potomac and extended on northward along the Blue Ridge to South Mountain, southwest of the

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[1] Am. Jour. Sci., 3d ser., Vol. XLVII, 1894, pp. 309–311.

[2] The Potsdam Group east of the Blue Ridge, at Balcony Falls, Va.: Am. Jour. Sci., 3d ser., Vol. XXIX, 1885, p. 472.

[3] Notes on the Cambrian Rocks of Virginia and the Southern Appalachians: Am. Jour. Sci., 3d ser. Vol. XLIV, 1892, p. 53.

Susquehanna, in Pennsylvania. His various sections of the Blue Ridge show an overturn of the Primal strata to the westward, which gave that and the superjacent Valley limestone an easterly dip. If he had at that time understood the phenomena of thrust faults, I think he would have interpreted the structure to be a thrusting (often of a synclinal fold) of the older Primal beds over on the superjacent limestone, instead of an overturned anticlinal fold.

The section at Monterey, and along that portion of the Blue Ridge, as estimated from the data obtained by Mr. Keith to the south and from the Monterey section, is as follows, reading from above downward:

Section at Monterey, Va.

(The upper portion of the section is preceded by the Valley limestone, more or less of the lower portion of which is probably of Middle and Upper Cambrian age.)

	Feet.
6. Mottled limestone, with intercalated sandy and shaly layers. Fossils: Kutorgina n. sp. and fragments of Olenellus	800 to 1,000
5. Sandy shales, with a series of calcareous quartzite near the summit. Fossils: *Camarella minor, Hyolithes communis,* and fragments of Olenellus. About	450
4. Scolithus quartzite, with interbedded calcareous sandstones and shales. Fossils: *Camarella minor* and fragments of Olenellus	500
3. Sandy shale, with interbedded layers of quartzite	800
2. Coarse-grained and bluish-gray quartzite	1,000 to 1,200
1. Shales and slates, well shown near Mechanicstown, Md., and in numerous sections along the Blue Ridge	300 to 400

(At several localities the shales of No. 1 appear to be replaced by bands of conglomerate, and many of the layers of No. 2 are to a greater or less extent a conglomerate.)

The section includes from 3,000 to 3,500 feet of sandstones and shales before reaching the limestones. In a number of localities a conglomerate was observed in the lower sandstone series in which fragments of the pre-Paleozoic crystalline rocks were embedded. This phenomenon was observed on South Mountain, in the conglomerate mentioned by Professor Lesley, and also along the Blue Ridge and the Catoctin Ridge to Harpers Ferry, the conglomeritic character of the rocks varying very much in the character and size of the coarser material. The feldspathic character of these shales and sandstones is very distinctly marked beneath the Scolithus quartzite, in both the Balcony Falls and the Monterey sections. If these two sections are compared with that at Chickies Rock and south to Columbia, in Lancaster County, Pa., it will be at once observed that the Scolithus quartzite, while the highest band of quartzite in the Balcony Falls and the Monterey sections, is the lowest in the Chickies Rock section, which has the lowest feldspathic sandstone and shales apparently above the Scolithus quartzite. It is from this fact that it is stated, in the first part of this paper, that the feldspathic sandstones and shales were thrust over on the Scolithus sandrock in the Chickies section.



VIEW OF AN OLD LIMEKILN AT BELLEMONTE, LANCASTER COUNTY, PENNSYLVANIA, ON THE MAIN LINE OF THE PENNSYLVANIA RAILROAD.

On Pl. II of Bulletin No. 81 of the United States Geological Survey, section 9 is intended to illustrate the Cambrian rocks of central Pennsylvania. It gives the data known at that time, but my recent reconnaissance has disclosed the fact that a section similar to that of Tennessee (section 11) will more fairly represent the Cambrian rocks on the Susquehanna and to the southwest into Maryland.

The discovery of the Olenellus or Lower Cambrian fauna in the Reading sandstone practically completes the correlation of the South Mountain, Chickies, and Reading quartzites, and establishes the correctness of the early correlations of McClure, Eaton, Emmons, and Rogers. They all considered the basal quartzite as the same formation from Vermont to Tennessee; and the discoveries of recent years have proved that the basal sandstones of Alabama, Tennessee, and Virginia (Chilhowee quartzite); Maryland, Pennsylvania, and New Jersey (the Reading quartzite); New York and Vermont (Bennington quartzite), were all deposited in Lower Cambrian time, and that they contain the characteristic Olenellus fauna throughout their geographic distribution. The superjacent limestones carry the Olenellus fauna in their lower portions in northern and southern Vermont, eastern New York, New Jersey, and Pennsylvania. To the south of Pennsylvania the lower portions of the limestones appear to be represented by shales, and the Upper and Middle Cambrian faunas are found in the lower half of the Knox dolomite series of Tennessee, and they will probably be discovered in the same series in Virginia and Maryland when a thorough search is made for them. The same may be predicted, but with less assurance, for the northern belt of limestone crossing Pennsylvania into New Jersey, as the limestones between the Olenellus zone and the Trenton zone represent the intervals of the Middle and Upper Cambrian and the lower Ordovician, or the Calciferous and Chazy zones of the New York section. The working out of the details of this section in southeastern Pennsylvania is an interesting problem, left for solution to some geologist who has the necessary paleontologic training, and who will not be discouraged by the prospect of a good deal of hard work before the desired result can be obtained.

The problem of where to draw the line in this series of limestones, on a geologic map, between the Cambrian and Ordovician, is one that will seriously embarrass the geologist, but I anticipate that either lithologic or paleontologic characters will be discovered by which the two groups can be differentiated. If not, the limestones must be colored as one lithologic unit or formation, as on Pl. I, and the approximate line of demarcation between the Cambrian and Ordovician must be indicated in the columnar section accompanying the legend of the map.

INTRAFORMATIONAL CONGLOMERATES.

In a recent article[1] I have discussed under this title a conglomerate formation, some of the principal illustrations of which occur in the Cambrian rocks of Pennsylvania. As this is a somewhat unusual phenomenon, but one that will be seen with comparative frequency in Pennsylvania, I here append my observations on the subject, and also reproduce the illustrations of the Pennsylvania localities.

DEFINITION OF TERM AND ILLUSTRATION.

An intraformational conglomerate is one formed within a geologic formation of material derived from and deposited within that formation. An illustration occurs in the old limestone quarries on the east shore of the Hudson, below Schodack Landing, Rensselaer County, N. Y. The section is formed of thinly bedded limestone carrying the typical Olenellus fauna. Toward the summit of the quarry a band of limestone conglomerate rests conformably on the bedded limestone. Pebbles and fragments of several varieties of limestone occur, in which fragments of typical species of the Olenellus fauna were found. The conglomerate band varies in thickness from 2 to 6 feet, and is capped by thinly bedded limestones that carry the same species of fossils as the limestones beneath the conglomerate and the bowlders in the conglomerate. It shows that the limestone pebbles, bowlders, and brecciated fragments were formed from a calcareous sediment sufficiently consolidated to be broken up and more or less rounded by attrition, and these collected to form a bed of conglomerate, the matrix of which is usually calcareous. This section clearly proves the formation of conglomerate within the Lower Cambrian terrane, the materials of which were derived from limestones deposited during Lower Cambrian time.

The conglomerate at the locality described is not so clearly marked as are some in the Lower Cambrian terrane of Lancaster and York counties, Pa., and the conglomerates at the base of the great Ocoee series of Tennessee. The limestone conglomerates of the Cambrian and Ordovician of the St. Lawrence Valley are not typical illustrations of true intraformational conglomerates, but I shall speak of them, as they appear to have been formed under somewhat similar conditions.

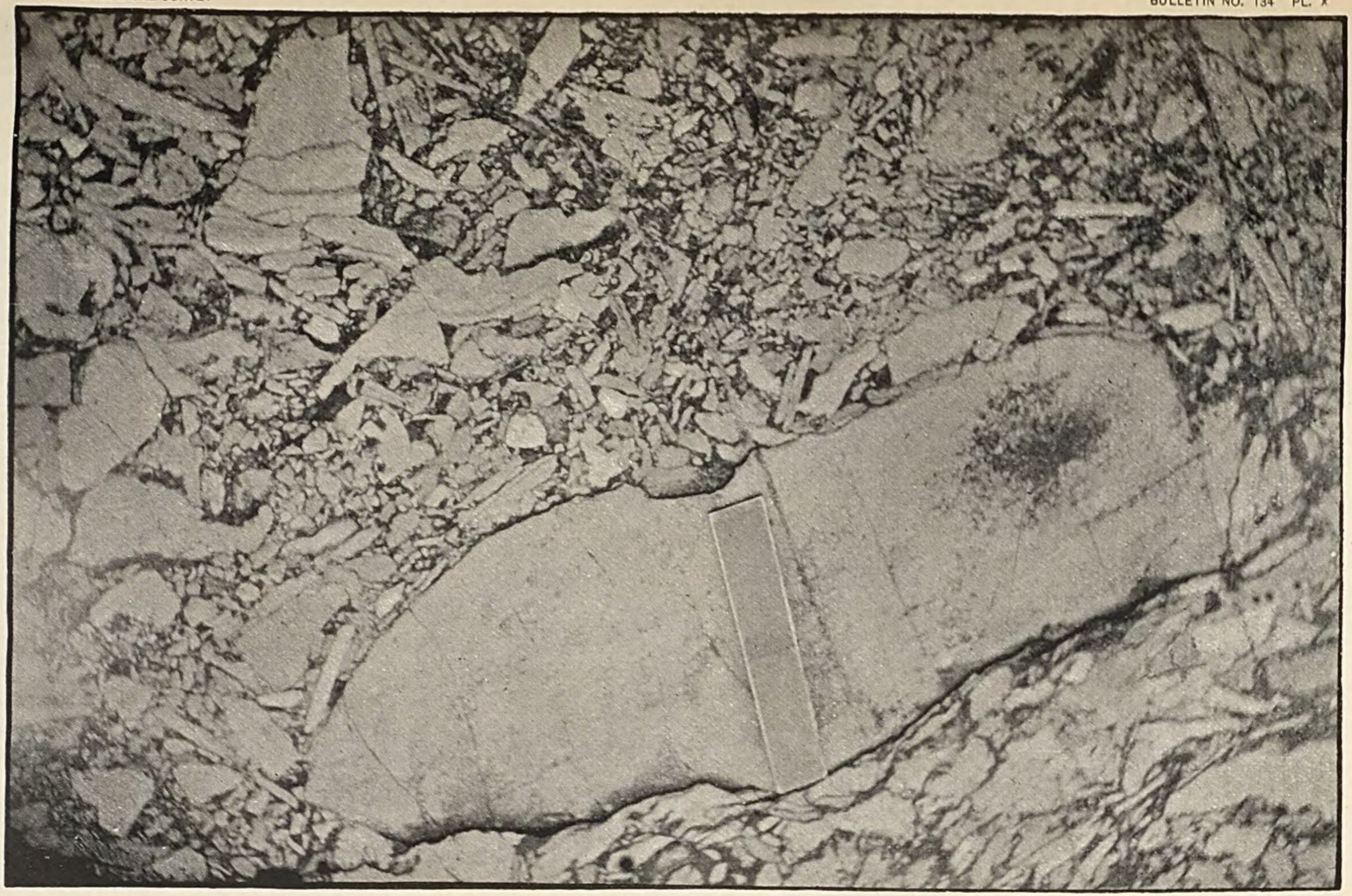
CANADIAN LOCALITIES.

Sir W. E. Logan has graphically described the limestone and conglomerates of the south shore of the St. Lawrence at Trois Pistoles, Bic, Metis, the vicinity of Quebec, and the west coast of Newfoundland.[2] During the summer of 1889 I had an opportunity to examine the sections of the Ordovician and Cambrian rocks in the vicinity of

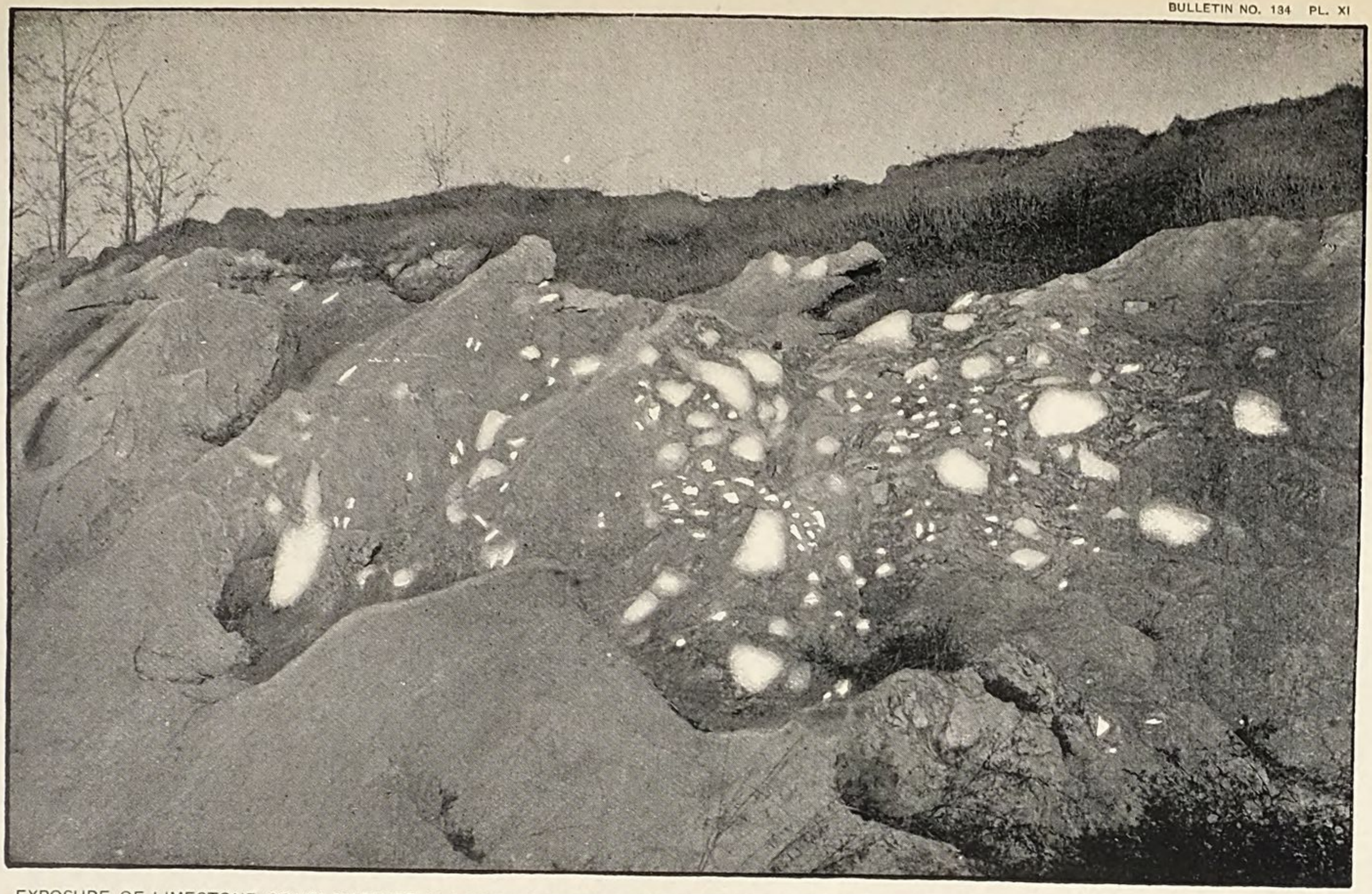
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[1] Bull. Geol. Soc. Amer., Vol. V., 1894, pp. 191-198, Pls. V-VII.

[2] Geology of Canada, 1863, pp. 227, 260, 261.



BRECCIATED LIMESTONE CONGLOMERATE IN LOWER ORDOVICIAN SOUTHEAST OF HIGHGATE SPRINGS, FRANKLIN COUNTY, VERMONT.



EXPOSURE OF LIMESTONE CONGLOMERATE IN LOWER CAMBRIAN LIMESTONE IN QUARRY ON EAST SIDE OF YORK, PENNSYLVANIA, WITHIN THE CITY LIMITS.

Quebec, and I was very much impressed by the mode of occurrence of the limestone conglomerates. The lowest bed of conglomerate occurs in the Sillery shales on the south shore of the St. Lawrence below Levis and on the south shore of the island of Orleans. The limestone bowlders show transportation, and are mingled with pebbles of quartz, sandstone, etc. The Olenellus fauna occurs abundantly in the fragments of limestone, but the source of the limestone is unknown. It is, however, of Cambrian age, and it has been redeposited about 1,500 feet from the summit of the series of shales, sandstones, etc., that are referred to the Cambrian.[1]

The lower bed of limestone conglomerate at Point Levis occurs near the base of the Ordovician, in the Point Levis shale. It is made up of large and small bowlders of limestone, carrying the Upper Cambrian fauna, that are embedded in the limestone matrix in which occurs the typical Calciferous fauna. The matrix is a hard, gray, impure limestone, which forms solid layers that were traced for over 500 feet on the strike. As in the case of the limestone bowlders carrying the Olenellus fauna, the origin of the bowlders carrying the Upper Cambrian fauna is unknown, as no beds of limestone of a similar character have been found in the Sillery shales, upon which the Ordovician shales and interbedded conglomerate rest. The matrix of the conglomerate proves the formation to be of lower Ordovician age. In a bed of limestone 50 feet higher up in the section I found additional species of the Calciferous fauna, and in a bed of limestone conglomerate above this the fossils in the bowlders, and in the matrix as well, are of Calciferous age. In a search of two days I failed to find a Cambrian fossil at this horizon, although such a discovery might be anticipated from the occurrence of the older limestones in the conglomerates beneath. This second band of conglomerate in the Levis series appears to be true intraformational conglomerate. The limestone conglomerates embedded in the shales and shaly limestones beneath the city of Quebec are of much less stratigraphic importance than are those at Point Levis; but the same conditions of deposition appear to have existed during the formation of these rocks of middle Ordovician (Chazy-Trenton) time.

VERMONT AND NEW YORK LOCALITIES.

In the passage beds between the Cambrian and Ordovician east of Highgate Springs, Franklin County, Vt., layers of limestone conglomerate occur (Pl. X), some of the fragments of which carry the lower Ordovician fauna. The horizon of the conglomerate appears to be within the range of this fauna, and points to an intraformational origin.

The type that has already been described as occurring at Schodack Landing, N. Y., has been observed at many localities to the north, in Washington County, N. Y., where it is a common feature of the Lower Cambrian terrane.

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[1] Am. Jour. Sci., 3d ser., Vol. XXXIX, 1890, pp. 112–113.

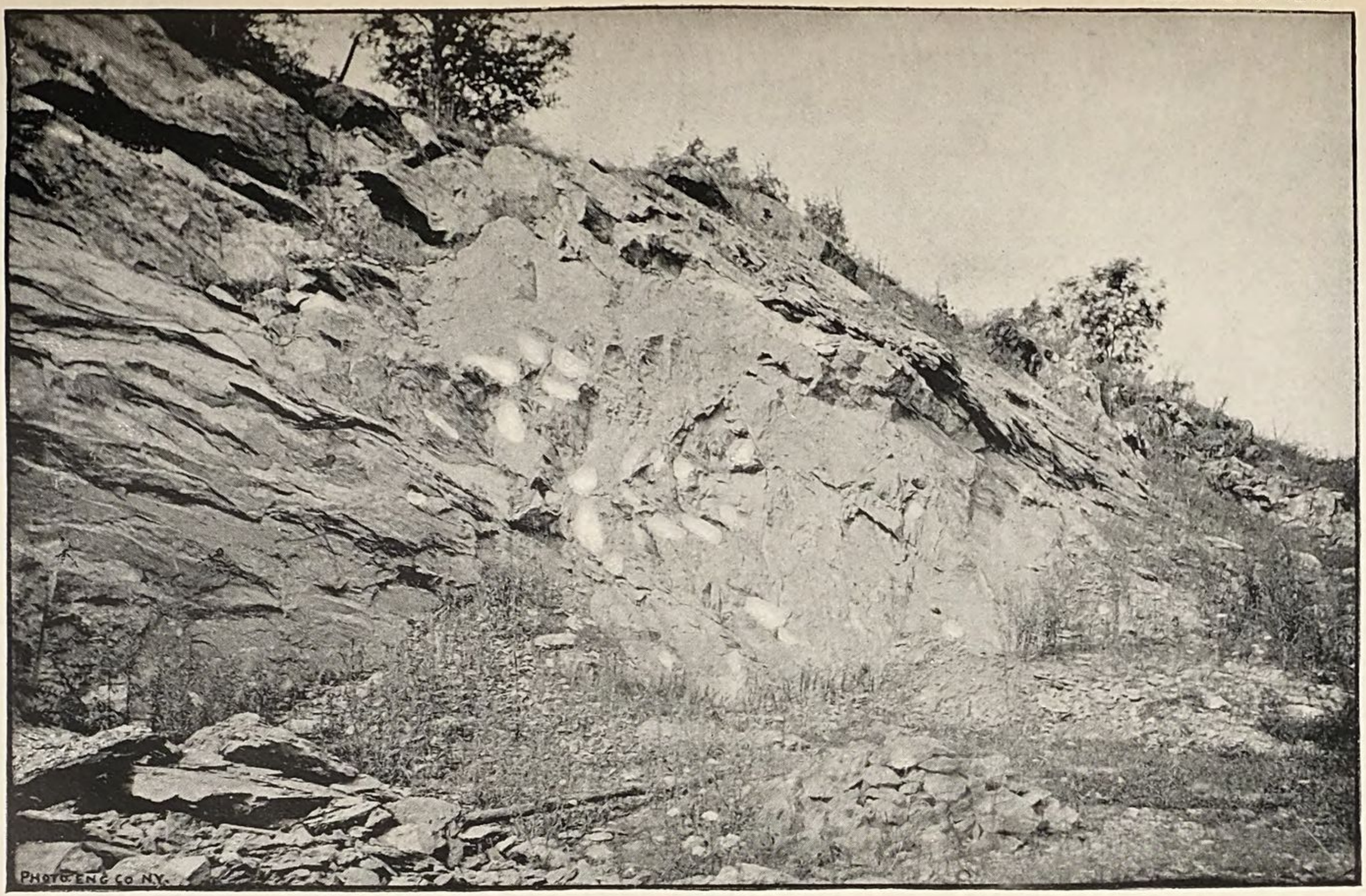
PENNSYLVANIA LOCALITIES.[1]

The succession of Cambrian rocks in York and Lancaster counties, Pa., is very clearly defined. A massive quartzite is succeeded by shales, and then comes a massive-bedded, more or less siliceous limestone that varies in color and composition in its several beds. This massive bed of limestone is succeeded in numerous instances by beds of limestone conglomerate, which are interbedded in more or less thinly bedded, somewhat shaly limestones. One of the most clearly defined sections is exposed at Bellemont, Lancaster County, on the line of the Pennsylvania Railroad. The massive blue and white Cambrian limestones are succeeded by a few feet of a blue, earthy limestone and shale, and upon this there is a bed of limestone conglomerate, from 8 to 10 feet in thickness, that is made up largely of pebbles and bowlders of limestone derived from the limestone beds beneath. (Pl. VII.) A second bed of conglomerate is seen on the roadside to the north.

About 40 miles west of Bellemont, at Stoners Station, on the York and Wrightsville Railroad, York County, Pa., an extensive and beautiful exposure of the Lower Cambrian limestones and conglomerate may be seen in an old quarry just east of the wagon road, one-fourth of a mile north of the railroad track. (Pl. XII.) Alternating bands of thinly bedded limestone and massive beds of limestone conglomerate form about 100 feet of the exposed section, in which five beds of the conglomerate limestone are well shown. The basal bed has a fine-grained, gray limestone matrix with brecciated limestone fragments in it, which range in size from that of small shot to masses 3 feet in diameter. These pebbles and bowlders vary in lithologic character, some resembling the matrix and others being oolitic, arenaceous, semi-marbleized, and shaly limestones. The thinly bedded limestones separating the conglomerate bands are from 4 to 6 feet in thickness, and are very clearly defined.

In the second band of conglomerate the larger bowlders occur in the lower portion. The other three beds vary in details, but they are all formed of the same type of rock. One of the upper beds contains a multitude of small fragments of limestone. It was impracticable to obtain a photograph of the basal beds, which contain the largest bowlders. Pl. XII illustrates the evenly bedded limestones above and beneath the third band, and also shows the character of some of the limestone bowlders. In the shaly limestone at the base of this bed a larger bowlder, 2 feet or more in diameter, is entirely embedded in the shaly limestone. This bowlder, as shown in Pls. XIII and XIV, was evidently deposited on the bed of the sea, and the calcareous mud

[1] Mr. Frederick Prime, jr., noted the brecciated conglomerates in the limestone of Lehigh and Northampton counties, Pa. They occur between bands of unbroken limestone, and he explained the phenomenon by the fracture of unyielding beds between two more pliable ones and recementing *in situ* by the percolation of calcareous waters. (On the Paleozoic Rocks of Lehigh and Northampton counties, Pa.: Amer. Philos. Soc., Proc., Vol. XVII, 1878, p. 250.)



LIMESTONE CONGLOMERATE AT QUARRY ONE-FOURTH MILE NORTH OF STONERS STATION, YORK AND WRIGHTSVILLE RAILROAD, YORK COUNTY, PENNSYLVANIA.



VIEW OF A BOWLDER IN THE THIN-BEDDED LIMESTONE BETWEEN THE BEDS OF LIMESTONE CONGLOMERATE AT QUARRY ONE-FOURTH MILE NORTH OF STONERS STATION, YORK AND WRIGHTSVILLE RAILROAD, YORK COUNTY, PENNSYLVANIA.

gathered quietly about it. At about the same horizon, in a quarry on the east side of York, a massive bed of limestone conglomerate is beautifully shown. A photograph of it is reproduced as Pl. XI.

The quartzites, shales, and limestones beneath these beds of conglomerate are known to carry the Lower Cambrian or Olenellus fauna; and the same fauna, with the exception of details of variation of species, occurs in the limestones and shales above the conglomerates, thus placing the latter within the definition of intraformational conglomerates.

VIRGINIA LOCALITIES.

Mr. M. R. Campbell[1] informs me that in the vicinity of Radford, Va., there is a formation that appears to be a true intraformational conglomerate. He states that it is in the great Cambro-Silurian limestone, and consists of a yellowish-white, chalky limestone matrix in which are embedded rounded fragments of limestone that are similar in composition to the matrix, and that can be distinguished from it only with difficulty. A few small grains of foreign material were observed. The exact stratigraphic horizon could not be determined, owing to the complexity of the structure and the poor exposures. Two miles below Radford the actual contact was observed between the conglomerate and the bedded limestone, where the former rests on the cut edges of the folded limestones beneath. Mr. Campbell believes this indicates shore conditions, contortion of the limestone deposits, and their elevation above sea-level to form cliffs that supplied material for later beds of the same great formation.

Another case of this kind was observed by Mr. Campbell at a horizon northwest of Bristol, Va. He found that here the conglomerate occurs in a bed of shaly limestone, only a few feet thick, that belongs in the Nolichucky (Cambrian) shales. This bed appears to have been broken up largely into flat fragments that were quite well worn on their edges, and then redeposited in the same bed and cemented into a solid mass of limestone. The peculiar features of this deposit are its extreme thinness and apparent freedom from all marks of erosion. It is quite persistent, and no evidence of an unconformity was observed.

TENNESSEE LOCALITIES.

The intraformational conglomerates already described have been identified as such by the presence of similar fossils in the bowlders of the conglomerate and the superjacent and subjacent bedded limestones. Those about to be described are identified entirely by lithologic characters. These, however, are so clearly defined and are of such variety that the conclusions based upon them are considered to be nearly as reliable as those where fossils are present.

In Tennessee these conglomerates occur in the lower portion of the Ocoee terrane of Safford. Mr. Arthur Keith named the basal slate the

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[1] Paleozoic Overlaps in Montgomery and Pulaski Counties, Va.: Bull. Geol. Soc. of Am., Vol. V, pp. 175-176.

Wilhite. This slate rarely exceeds 700 feet in thickness, and it is capped by the siliceous Citico conglomerate (Keith). Within the Wilhite slate, especially in the upper 200 feet, and along its strike for over 100 miles, numerous beds of limestone occur. Usually a limestone conglomerate is found in the same section, generally above the bedded limestone. These limestone conglomerates have been cited as proof that the Wilhite slates were of later age than the Ordovician limestones, which, it was assumed, furnished the pebbles and bowlders of the limestone conglomerates; and hence, it was concluded, the Ocoee terrane, instead of being an older formation than the great limestone series of Tennessee, is of later date, and consequently of post-Ordovician age.

In company with Mr. Keith I visited numerous localities of the Wilhite slate in Cocke, Sevier, and Blount counties. At a locality 3 miles S., 65° E. of East Fork, Sevier County, a limestone conglomerate occurs by the roadside, and also on the north side of the road, on Stephen Huff's farm. The bedded limestones vary in texture and color and in the presence or absence of more or less arenaceous material, but the weathered surfaces of many of the beds are very characteristic. At the locality by the roadside there is little, if any, of the bedded limestone exposed, the conglomerates resting on calcareous shale or slate containing compressed lentils of impure bituminous limestone. The conglomerate is formed of brecciated and rounded pebbles and bowlders of limestone and, more rarely, of a fine-grained sandstone. The limestone bowlders vary in lithologic characters from pure white limestone to sandy and siliceous and their various combinations. In color they are blue, gray, black, purple, white, pinkish, dove, etc. About 2 miles to the north of this locality, on Wilhite Creek, there occurs a somewhat similar conglomerate, in which the limestone bowlders reach a diameter of from 3 to 4 feet. A peculiarity of the conglomerate at these places is the presence of large bowlders in the slate above the main body of the conglomerate.

At a locality 2 miles east of Jones Cove, Sevier County, an interesting phase of the conglomerate is the presence of bowlders of a dark, sandy limestone embedded in the mass of the bedded limestone that occurs below and also above the conglomerate. The matrix of the conglomerate is frequently largely made up of a sandy limestone of the same lithologic aspect as the bedded limestones out of which the bowlders of the conglomerate were made. The limestone conglomerate was also noted at a locality 3 miles south of Del Rio, Cocke County, where it occurs above the limestone in the Wilhite slate.

One of the best localities at which to study the relations of the limestones and conglomerates is on the north side of the entrance to the narrows of the Little Tennessee River, in Blount County. Here the bedded limestones in the Wilhite slates are beautifully exhibited, and above them the limestone conglomerate is strongly marked, and bowlders of the limestone over 6 feet in diameter occur in the lower portion of the Citico conglomerate. Another peculiarity at this locality is that



NEARER VIEW OF THE BOWLDER SHOWN IN PLATE XIII, SEEN FROM A DIFFERENT DIRECTION.

the limestones within the Wilhite slate were broken up and many of the fragments rounded to form a bed of conglomerate just above the horizon of the limestone beds from which, elsewhere, they were derived, and the same process was repeated with the bed of conglomerate. We found in an upper bed of conglomerate bowlders formed of masses of conglomerate of the same character as that in the stratum some distance below in the section. In this upper conglomerate numerous quartz pebbles of the same character as those of the Citico conglomerate are embedded in the limestone matrix. Special effort was made, by both Mr. Keith and myself, to discover evidence of the presence of limestones of a character different from that of those found conformably bedded in the Wilhite slate, but without success. The limestones of the Wilhite slates are so marked in their lithologic characters, and the bowlders in the conglomerates have lithologic characters so similar, that we did not hesitate to refer the source of the material of the latter conglomerate to the limestone beds within the Wilhite formation. At one locality, 2 miles S., 10° W. of Sweetwater, Cocke County, a sandstone rests unconformably upon the Knox limestone and contains rounded pebbles of the limestone carrying the characteristic fossils which are embedded in the limestone beneath the sandstone. This sandstone occurs in the isolated outcrop and is not known to be of Ocoee age.

ORIGIN.

The relation of the bedded limestone to the superjacent conglomerates proves that the calcareous mud which was subsequently consolidated into the limestones solidified soon after deposition. This is shown by the presence in the conglomerate of rounded pebbles and angular fragments of limestone with sharp, clear-cut edges. The presence of the conglomerates above the limestone beds, from some portion of which they were derived, leads me to believe that the sea bed was raised in ridges or domes above the sea-level and thus subjected to the action of the seashore ice, if present, and the aerial agents of erosion. From the fact that the limestones upon which the conglomerates rest rarely, if ever, show traces of erosion where the conglomerates come into contact with them, the inference is drawn that the débris worn from the ridges was deposited in the intervening depressions beneath the sea. In the case of the conglomerates of the Wilhite slates of Tennessee, it is exceptional to find a bedded limestone above them; but within the Lower Cambrian of Pennsylvania and New York the conglomerates are interbedded in the limestones.

Large bowlders of limestone were observed in the Wilhite slates on Wilhite Creek, Tennessee, above the main conglomerate bed, and large bowlders of limestone were observed in the bedded limestones at Stoner's quarry, Pennsylvania. The mode of occurrence of these bowlders, especially those in the limestones at Stoner's quarry, leads to the view that they may have been dropped upon the sea bed from floating ice. No other explanation occurs to me that will account for the transpor-

tation of a bowlder from the shore-line and the placing of it upon the sea bed so as not to disturb to any marked degree the sediment then accumulating. In the special example at Stoner's quarry 2 feet of calcareous mud was deposited in thin layers about the bowlder, and as much more above it, before the introduction of conditions that led to the deposition of the next stratum of conglomerate.[1]

The history of Appalachian sedimentation and mountain-building proves that a more or less constant movement was taking place from Algonkian time to the close of the Paleozoic.[2] This movement was at times greatly prolonged, and resulted in marked topographic features. More frequently the minor movements produced local effects, and some of them resulted in the formation of the conglomerates described.

MODE OF FORMATION OF THIN-BEDDED BRECCIAS.

The mode of formation of a brecciated limestone conglomerate, illustrated by Pl. X, has often puzzled me when studying Paleozoic rocks. Geologists frequently observe layers composed almost entirely of thin-bedded, brecciated limestones, or of sandy or argillaceous shales. In many cases the layers of breccia are not more than an inch or two in thickness and occur between layers formed of undisturbed sediment. The breccia is often composed of angular fragments varying from a quarter of an inch to half an inch in thickness, while in the thicker layers of the breccia fragments an inch or more in thickness occur.

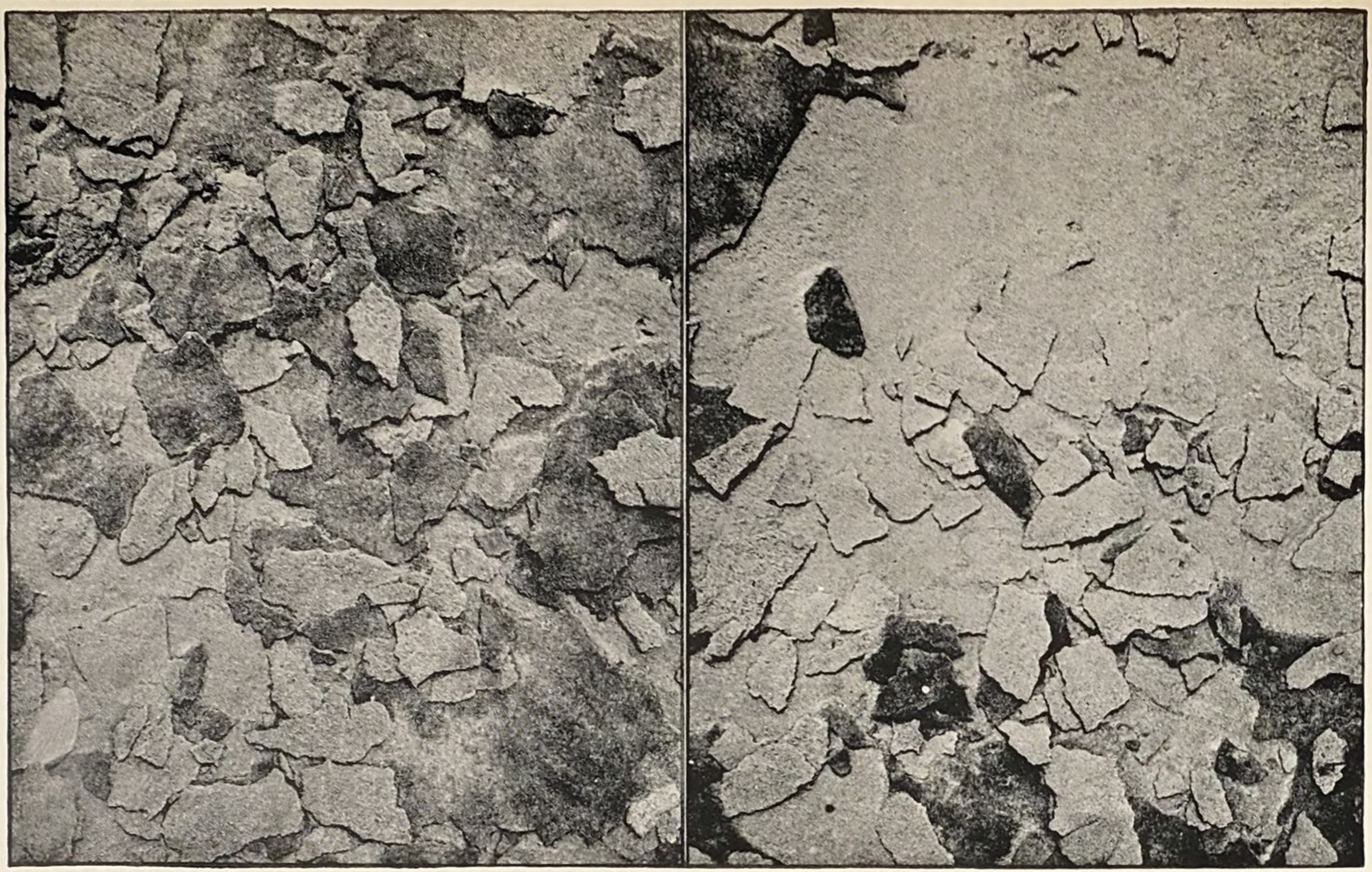
During the summer of 1895, when making observations on the flats exposed at low tide in the inlet west of Noyes Point, Rhode Island, I noticed that when the tide went out before daylight the layer of fine sand and mud exposed to the dry wind and sun during the day hardened, and that when the surface of the water of the incoming tide was broken by small waves the hardened layer was lifted, broken into angular fragments, and piled in some places to a depth of several inches, while in other places it was simply turned over and was very little disturbed. When much disturbed the edges of the fragments were rounded, so as to give them the appearance of having been rolled a considerable distance. In one instance the ensuing outflowing tide deposited a thin layer of sand and silt over the brecciated fragments. From these observations it is evident that should the same phenomena occur on a sinking shore-line, breccias of the character so often met with by the field geologist would be formed.

On Pl. XV parts of two photographs taken by me on the occasion referred to illustrate a portion of the breccia formed on the flat in the inlet west of Noyes Point.

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[1]Sir William Dawson says that the "only means of explaining these conglomerates [Quebec, Point Levis, Metis] seems to be the action of coast ice, which at this period appears to have been as energetic on the American shores as at the present day, and seems to have had great reefs of limestone, probably in the area of the Gulf of St. Lawrence, to act upon and to remove in large slabs and bowlders, piling these up on banks, to constitute masses of conglomerate." (Quart. Jour. Geol. Soc. London, Vol. XLIV, November, 1888, pp. 809, 810.)

[2]See articles by Willis, Thirteenth Annual Report of U. S. Geol. Surv., 1893, Pt. II, pp 217-274, and by Keith, Proc. Philos. Soc. Washington, 1892, Vol. XII, pp. 71-88, Pl. I.



BRECCIATED LAYER OF FINE SAND AND SILT PRODUCED BY THE INFLOWING TIDE BREAKING UP THE LAYER HARDENED BY SUN AND WIND ON TIDAL FLAT IN INLET WEST OF NOYES POINT, RHODE ISLAND.

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IX. Ninth Annual Report of the United States Geological Survey, 1887–'88, by J. W. Powell. 1889. 8°. xiii, 717 pp. 88 pl. and maps.

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"*Provided*, That hereafter the report of the mineral resources of the United States shall be issued as a part of the report of the Director of the Geological Survey."

In compliance with this legislation, the report Mineral Resources of the United States for the Calendar Year 1894 forms Parts III and IV of the Sixteenth Annual Report of the Survey, and Mineral Resources of the United States for the Calendar Year 1895 forms Part III of the Seventeenth Annual Report of the Survey.

The money received from the sale of these publications is deposited in the Treasury, and the Secretary of the Treasury declines to receive bank checks, drafts, or postage stamps; all remittances, therefore, must be by POSTAL NOTE or MONEY ORDER, made payable to the Director of the U. S. Geological Survey, or in CURRENCY, for the exact amount. Correspondence relating to the publications of the Survey should be addressed

TO THE DIRECTOR OF THE
UNITED STATES GEOLOGICAL SURVEY,
WASHINGTON, D. C.

WASHINGTON, D. C., *June*, *1896*.

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UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

BIBLIOGRAPHY AND INDEX

OF

NORTH AMERICAN GEOLOGY, PALEONTOLOGY, PETROLOGY, AND MINERALOGY

FOR

THE YEAR 1894

BY

FRED BOUGHTON WEEKS



WASHINGTON

GOVERNMENT PRINTING OFFICE

1896

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LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
DIVISION OF GEOLOGY,
Washington, D. C., October 22, 1895.

SIR: I have the honor to transmit herewith the manuscript of a Bibliography and Index of North American Geology, Paleontology, Petrology, and Mineralogy for the year 1894, by Mr. F. B. Weeks, with the recommendation that it be published by the Survey. It is planned on the same lines with that for 1892–93, by the same author, and bears evidence of the same careful preparation.

Very respectfully,

S. F. EMMONS,
Geologist.

Hon. CHARLES D. WALCOTT,
Director United States Geological Survey.

BIBLIOGRAPHY AND INDEX OF NORTH AMERICAN GEOLOGY, PALEONTOLOGY, PETROLOGY, AND MINERALOGY FOR THE YEAR 1894.

By FRED BOUGHTON WEEKS.

INTRODUCTION.

This work is a continuation of the Bibliography and Index for 1892 and 1893 (Bulletin No. 130), and records the papers on North American geology, paleontology, petrology, and mineralogy published in the year 1894, almost all of which appeared in the serials composing the List of Publications Examined, immediately following.

Bibliography.—The Bibliography consists of full titles of separate papers, classified by authors, an abbreviated reference to the publication in which the paper is printed, and a brief summary of the contents, each paper being numbered for index reference. The extent of papers less than a single page in length is indicated, as $\frac{1}{3}$ p., 5 l. (lines).

Index.—The subject headings, their subdivisions and arrangement, are shown in the Classified Key to the Index. They comprise geographic, geologic, mineralogic, paleontologic, and petrologic subdivisions. Under Economic Geology is given a list of useful minerals and ores described in publications examined; under Mineralogy, a list of minerals described in such publications; under Paleontology, a list of genera and species of fossils therein described; and under Petrology, a list of rocks described; reference being made in each case, by author's name and number of article in the Bibliography, to the paper in which the fossil, mineral, or rock is described.

LIST OF PUBLICATIONS EXAMINED.

Alabama, Geological Survey: Geological map of Alabama with explanatory chart; Report on the geology of the Coastal Plain of Alabama. Montgomery, Ala.

Alabama Industrial and Scientific Society: Proceedings, Vol. IV, Nos. 1-2. Tuscaloosa, Ala.

American Academy of Arts and Sciences: Proceedings, Vol. XXIX. Boston, Mass.

American Association for the Advancement of Science: Proceedings, Vol. XLII. Salem, Mass.

American Geologist, Vols. XIII-XIV. Minneapolis, Minn.

American Institute of Mining Engineers: Transactions, Vols. XXII-XXIII. New York.

American Journal of Science, 3d ser., Vols. XLVII-XLVIII. New Haven, Conn.

American Museum of Natural History: Bulletin, Vol. VI. New York.

American Naturalist, Vol. XXVIII. Philadelphia, Pa.

American Philosophical Society: Proceedings, Vol. XXXII, No. 143, and Vol. XXXIII, Nos. 144-146. Philadelphia, Pa.

Annals and Magazine of Natural History, Vols. XIII-XIV. London.

Appalachia, Vol. VII, No. 3. Boston, Mass.

Arkansas, Geological Survey: Annual Report, 1891, Vol. II; 1892, Vol. II. Little Rock, Ark.

Boston Society of Natural History: Proceedings, Vol. XXVI, Parts I-III. Boston, Mass.

Botanical Gazette, Vol. XIX. Madison, Wis.

British Association for the Advancement of Science: Report for 1893. London, England.

Buffalo Society of Natural Sciences: Bulletin, Vol. V, No. 4. Buffalo, N. Y.

California, Academy of Science: Proceedings, 2d ser., Vol. IV, Part I. San Francisco, Cal.

California, State Mining Bureau: Twelfth Report, State Mineralogist. Sacramento, Cal.

Canadian Institute: Transactions, Vol. IV, Part I. Toronto, Canada.

Canadian Record of Science, Vol. VI, Nos. 1-2. Montreal, Canada.

Cincinnati Society of Natural History: Journal, Vol. XVI, No. 4, and Vol. XVII, Nos. 1-3. Cincinnati, Ohio.

Connecticut, Academy of Arts and Sciences: Transactions, Vol. IX, Part I. New Haven, Conn.

Dennison University, Scientific Laboratories: Bulletin. Vol. VIII, Part 2. Granville, Ohio.

Edinburgh, Royal Society: Transactions, Vol. XXXVII, Part III. Edinburgh, Scotland.

Elisha Mitchell Scientific Society: Journal, 1893, and Part I, 1894. Raleigh, N. C.

Engineering and Mining Journal, Vols. LVII-LVIII. New York.

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Essex Institute: Bulletin, Vol. XXVI, Nos. 1-3. Salem, Mass.

Geological Magazine, Decade IV, Vol. I. London, England.

Geological Society of America: Bulletin, Vol. V. Rochester, N. Y.

Georgia, Geological Survey: Bulletin No. 1, a preliminary report on the marbles of Georgia; Bulletin No. 2, a preliminary report on the corundum deposits of Georgia. Atlanta, Ga.

Harvard College, Museum of Comparative Zoology: Bulletin, Vol. XXV and Vol. XVI, No. 1; Memoirs, Vol. XVII, No. 3. Cambridge, Mass.

Illinois, State Laboratory of Natural History: Bulletin, Vol. III, Article XIII. Peoria, Ill.

Indiana, Academy of Science: Proceedings, 1893. Brookville, Ind.

Indiana, Department of Geology and Natural Resources: Eighteenth Report. Indianapolis, Ind.

International Congress of Geologists: Compte Rendu, 5th session, 1891. Washington, 1893.

Iowa, Academy of Sciences: Proceedings, Vol. I, Part IV. Des Moines, Iowa.

Iowa, Geological Survey: Vol. II, Coal deposits of Iowa. Des Moines, Iowa.

Johns Hopkins University: Circulars, Vol. XIII. Baltimore, Md.

Journal of Geology, Vol. II. Chicago, Ill.

Journal of Morphology, Vol. IX. New York.

Kansas University Quarterly, Vol. I, Nos. 1–2, 1892; Vol. I, Nos. 3–4, and Vol. II, Nos. 1–2, 1893; Vol. II, Nos. 3–4, and Vol. III, Nos. 1–2, 1894. Lawrence, Kans.

Liverpool, Geological Society: Proceedings, Vol. VII, Part 2. Liverpool, England.

London, Geological Association: Proceedings, Vol. XIII, Nos. 6–9. London, England.

London, Geological Society: Quarterly Journal, Vol. L. London, England.

London, Royal Society: Proceedings, Vols. LIV–LV. London, England.

Manchester, Geological Society: Transactions, Vol. XXIII, Parts I–II. Manchester, England.

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National Geographic Magazine, Vol. VI. Washington, D. C.

Nautilus, Vol. VII, Nos. 9–12, and Vol. VIII, Nos. 1–8. Philadelphia, Pa.

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New York, State Museum: Forty-seventh Report. Albany, N. Y.

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Ohio, Geological Survey, Vol. VII. Columbus, Ohio.

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Paleontographica, Band XL, 1–6, and Band XLI, 1–2. Stuttgart, Germany.

Philadelphia Academy of Natural Sciences: Proceedings, 1894, Parts I–III; Journal, 2d ser., Vol. IX, Part IV. Philadelphia, Pa.

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Rochester Academy of Science: Proceedings, Vol. II, Brochure 3. Rochester, N. Y.

Royal Irish Academy: Transactions, Vol. XXX, Parts 11–14; Proceedings, 3d ser., Vol. III, Nos. 2–3. Dublin, Ireland.

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1 **Adams** (F. D.). On the occurrence of a large area of nepheline syenite in the township of Dungannon, Ontario.

Am. Jour. Sci., 3d ser., vol. xlviii, pp. 10–16.

Abstracts: Am. Geol., vol. xiv, pp. 189–190 (¼ p.); Am. Nat., vol. xxviii, p. 800 (⅔ p.).

Describes the occurrence and microscopic character of the rock and the contained minerals nepheline, plagioclase, mica, hornblende, scapolite, calcite, zircon, and sodalite.

2 **Agassiz** (Alexander). Notes from the Bermudas.

Am. Jour. Sci., 3d ser., vol. xlvii, pp. 411–416, figs. 1–7.

Discusses the formation of the reefs and the agency of algæ corallines and serpulæ in building up or protecting them from the action of the surf.

3 —— A reconnoissance of the Bahamas and of the elevated reefs of Cuba in the steam yacht *Wild Duck*, January to April, 1893.

Harv. Coll. Mus. Comp. Zool., Bull., vol. xxvi, pp. 1–203, pls. i–xlvii.

Abstract: Am. Geol., vol. xiii, p. 141 (⅛ p.).

Describes the topographic character of parts of the Bahamas and the distribution of corals, and discusses recent views on the formation of coral reefs.

4 **Aguilera** (José G.). The geology of Mexico.

Commission Geologico Mexicana.

Abstract: Am. Jour. Sci., 3d ser., vol. xlvii, pp. 78–79.

5 **Aldrich** (T. H.). The (Midway) Clayton Tertiary section and its fossils [Alabama].

Ala. Geol. Surv., Rept. on the geology of the Coastal Plain of Alabama, pp. 240–248, pls. xii–xv.

Describes the fossils occurring at this horizon, including six new species.

6 —— New Tertiary fossils from Red Bluff, Mississippi.

Nautilus, vol. vii, pp. 97–99.

Describes six new species from this locality.

7 **American Geologist.** The origin of spheroidal basalt.

Am. Geol., vol. xiv, pp. 321–326 (editorial comment).

Reviews a paper on the eruptive rocks of Point Bonita, by F. Leslie Ransome, and discusses certain features of the greenstones of the Lake Superior region.

8 **Ami** (H. M.). Notes on fossils from Quebec City, Canada.

Ottawa Nat., vol. viii, pp. 82–90.

Gives a list of 90 species occurring in the Silurian strata, near the city of Quebec.

B.

9 **Bäckström** (H.). Causes of magmatic differentiation.

Abstracts: Am. Geol., vol. xiii, pp. 194–195 (½ p.); Am. Nat., vol. xxviii, p. 515 (½ p.).

Noticed in Bibliography and Index for 1892 and 1893.

10 **Bain** (H. Foster). Structure of the Mystic coal basin [Iowa].

Iowa Acad Sci., Proc., vol. 1, pt. iv, pp. 33–36.

Describes the lithologic character of the beds and gives several sections displayed at various localities.

11 —— Sigourney deep well [Iowa].

Iowa Acad. Sci., Proc., vol. i, pt. iv, pp. 36–38.

Gives the section of the well to the depth of 1,888 feet, and discusses the evidences as to age of the formations represented.

12 —— Peculiarities of the Mystic coal seam [Iowa].

Am. Geol., vol. xiii, pp. 407–411.

Describes the occurrence of this coal seam and the associated strata, which, in contrast with the complexity of structure and nonpersistence of the beds of the Coal Measures in other parts of Iowa, has an extent of about 50 miles north and south and 40 miles east and west.

13 **Baldwin** (S. Prentiss). Pleistocene history of the Champlain Valley.

Am. Geol., vol. xiii, pp. 170–184, with map and one figure.

Describes the deltas, moraines, and other glacial deposits of this region and the pre-Glacial and post-Glacial drainage systems.

13*a* **Ballard** (Hetty O.), **Crosby** (W. O.) and. Distribution and probable age of the fossil shells in the drumlins of the Boston basin.

Am. Jour. Sci., 3d ser., vol. xlviii, pp. 486–496.

See Crosby (W. O.) and Ballard (H. O.), No. 106.

13*b* **Barlow** (A. E.). Relations of the Laurentian and Huronian rocks north of Lake Huron.

Review: Am. Geol., vol. xiii. pp. 63–64 (⅛ p.).

Noticed in Bibliography and Index for 1892 and 1893.

14 **Barrois** (Charles). [Correlation of clastic rocks.]

Int. Cong. Geol., Compte Rendu, 5th session, pp. 172 and 175.

Remarks on the impossibility of comparing in detail the Paleozoic formations of Europe and North America.

15 **Barton** (G. H.). [Remarks on drumlins.]

Bost. Soc. Nat. Hist., Proc., vol. xxvi, pp. 23–25.

Reviews the theory advanced by Warren Upham in a paper on the origin of drumlins.

15*a* **Bascom** (Florence). The structure, origin, and nomenclature of the acid volcanic rocks of South Mountain, Pennsylvania.

Abstracts: Am. Geol., vol. xiii, pp. 122-123; Am. Nat., vol. xxviii, pp. 515–516.

Noticed in Bibliography and Index for 1892 and 1893.

16 **Bashore** (Harvey B.). The Harrisburg terraces [Pennsylvania].

Am. Jour. Sci., 3d ser., vol. xlvii, pp. 98–99.

Describes the gravel deposits in this vicinity.

17 **Bayley** (W. S.). The basic massive rocks of the Lake Superior region. IV. The peripheral phases of the great gabbro mass of northeastern Minnesota.

Jour. of Geol., vol. ii, pp. 814–825.

Describes the petrographic characters of the nonfeldspathic gabbros and the olivine-pyroxene and pyroxene aggregates, and discusses the relation of the basic rocks to the normal gabbro.

17*a* —— A summary of progress in mineralogy and petrography in 1893.

Colby University, Geol. Dept.

Abstract: Am. Geol., vol. xiv, p. 52 (8 l.).

18 **Beachler** (Charles S.). An abandoned Pleistocene river channel in eastern Indiana.

Jour. of Geol., vol. ii, pp. 62–65, with map.

Describes the evidences which indicate the former existence of a river chanel in Rush and Decatur counties in southeastern Indiana.

19 **Becker** (George F.). On certain astronomical conditions favorable to glaciation.

Am. Jour. Sci., 3d ser., vol. xlviii, pp. 95–113, figs. 1-3.

Abstract: Am. Geol., vol. xiv, pp. 191–192.

Discusses the variation of temperature as influenced by solar radiation and the effects of low eccentricity and high obliquity, and includes a calculation of sunshine per unit area. Concludes that the accumulation of glacial ice may be due to a combination of low eccentricity and high obliquity with a favorable disposition of land and water.

20 —— [The genesis of ore deposits.]

Am. Inst. Mg. Engrs., Trans., vol. xxiii, pp. 602–604.

Discusses a paper by F. Posepny on the same subject, noticed in Bibliography and Index for 1892 and 1893.

21 **Beecher** (C. E.). On the mode of occurrence and the structure and development of Triarthrus becki.

Am. Geol., vol. xiii, pp. 38–43, pl. iii.

Describes the peculiar mode of occurrence of the trilobites found in the Utica shale near Rome, N. Y., and describes and figures the structure of the legs and antennæ of Triarthrus becki.

22 —— The appendages of the pygidium of Triarthrus.

Am. Jour. Sci., 3d ser., vol. xlvii, pp. 298–300, pl. vii.

Abstract: Am. Geol., vol. xiii, p. 428 ($\frac{1}{3}$ p.).

Describes the appendages attached to the pygidium or caudal shield of Triarthrus.

22*a* **Beecher** (C. E.) and **Schuchert** (Charles). Development of the brachial supports in Dielasma and Zygospira.

Abstract: Am. Nat., vol. xxviii, p. 267 (⅔ p.).

Noticed in Bibliography and Index for 1892 and 1893.

23 **Bell** (Robert). Pre-Paleozoic decay of crystalline rocks north of Lake Huron.

Geol. Soc. Am., Bull., vol. 5, pp. 357–366, pls. 15–16.

Abstract: Am. Geol., vol. xiii, p. 214 (⅓ p.).

Discusses the evidence of pre-Paleozoic erosion, the conditions affecting this ancient erosion and the contacts of Archean and Paleozoic rocks. Discusses the significance of the absence of Paleozoic deposition and the effect of glacial denudation.

24 **Bergeat** (Alfred). Zur Kenntniss der jungen Eruptivgesteine der Republik Guatemala.

Zeit. der deut. geol. Gesell., Band xlvi, Heft 1, pp. 131–157.

Describes the physiography of the region and the geologic distribution, occurrence, and petrographic characters of the recent eruptive rocks of Guatemala.

25 **Berkey** (Charles P.). Preliminary report of leveling party.

Minn. Geol. and Nat. Hist. Surv., 22d Ann. Rept., pp. 134–140.

Describes the topographic charcter of portions of Cook County, Minn., and includes two profile sections showing the principal elevated regions, and tables showing the elevations of a number of localities above sea level.

26 **Blake** (William P.). The mineral deposits of southwest Wisconsin.

Am. Inst. Mg. Engrs., Trans., vol. xxii, pp. 558–568.

Describes the geology of the region and the character and structure of the ore deposits.

27 —— [The lead and zinc deposits of the Mississippi Valley.]

Am. Inst. Mg. Engrs., Trans., vol. xxii, pp. 621–634.

In discussion of paper by W. P. Jenney on the same subject.

28 —— [The genesis of ore deposits.]

Am. Inst. Mg. Engrs., Trans., vol. xxiii, p. 587 (½ p.).

In discussion of paper on the same subject by F. Posepny.

29 —— [Terrestrial submergence southeast of the American Continent.]

Geol. Soc. Am., Bull., vol. v, p. 21 (⅓ p.).

In discussion of paper by J. W. Spencer on the same subject.

30 —— Wisconsin lead and zinc deposits.

Geol. Soc. Am., Bull., vol. v, pp. 25–32.

Reviews the literature on these deposits, discusses the relation of deformation to ore deposition, the evidences of deformation and the general distribution of zinc in the Silurian seas, and gives the author's conclusions.

31 —— Trilobites in the "Oil Rock" horizon of the Trenton limestone.

Am. Geol., vol. xiv, pp. 133–134 (correspondence).

Mentions the occurrence of species of Ceraurus, Dalmania, Encrinurus, Orthis, Murchisonia, Orthoceras, Cypricardites, Raphistoma, Hyolithes, Streplelasma, and encrinal stems in the Trenton limestone of Wisconsin.

32 **Blake** (William P.). On the origin of ancient quartz rocks.
Science, vol. xxiii, pp. 141–142.
Discusses the origin of quartzites of pre-Cambrian strata.

32*a* **Boyle** (C. B.). A catalogue and bibliography of North American Mesozoic Invertebrata.
Abstract: Am. Geol., vol. xiv, p. 330 (⅓ p.).
Noticed in Bibliography and Index for 1892 and 1893.

33 **Branner** (John C.). Elevations in the State of Arkansas.
Ark. Geol. Surv., Ann. Rept. 1891, vol. ii, pp. 77–152.
Gives the elevations, determined by different methods, of certain points in the State.

33*a* —— Observations upon the erosion in the hydrographic basin of the Arkansas River above Little Rock [Ark.].
Ark. Geol. Surv., Ann. Rept. 1891, vol. ii, pp. 153–166.
Abstract: Jour. of Geol., vol. ii, p. 866 (½ p.).
Noticed in Bibliography and Index for 1892 and 1893.

34 —— Magmatic observations and meridian monuments established in Arkansas.
Ark. Geol. Surv., Ann. Rept. 1891, vol. ii, pp. 168–176.
Describes the location and character of monuments and the magmatic observations of certain points in Arkansas.

35 —— Bibliography of the geology of Arkansas.
Ark. Geol. Surv., Ann. Rept. 1891, vol. ii, pp. 319–340.
Gives a list of papers on the geology of Arkansas, arranged alphabetically by authors' names.

36 —— The geological surveys of Arkansas.
Jour. of Geol., vol. ii, pp. 826–836.
Reviews the work of the several geological surveys of Arkansas.

37 **Brewer** (W. M.). Notes on the Alabama gold ores.
Eng. and Mg. Jour., vol. lvii, pp. 57–58.
Describes the gold ore deposits of Tallapoosa County, Ala.

38 **Broadhead** (G. C.). Geological history of the Missouri Paleozoic.
Am. Geol., vol. xiv., pp. 380–388.
Describes the topography of the Ozark plateau, the mode of deposition of the strata and their deformation during Paleozoic time, and the dislocations and erosion that have since taken place.

39 **Brögger** (W. C.). On the formation of pegmatite veins.
Can. Rec. Sci., vol. vi, pp. 33-46 and 61–71.
Reviews the previous theories as to the formation of pegmatite veins and gives a résumé of the author's conclusions, indicating that these veins are magmatic eruptive veins formed under peculiar conditions.

40 **Brooks** (W. K.). The origin of the oldest fossils and the discovery of the bottom of the ocean.
Jour. of Geol., vol. ii, pp. 455–479.
Discusses the evidences which indicate that the fauna of the Lower Cambrian is an approximation to the primitive fauna, and that prior to the Lower Cambrian animal life was represented by minute animals not likely to be preserved as fossils.

41 **Brown** (R. G.). The Georgetown mining district, Montana.

Eng. and Mg. Jour., vol. lviii, pp. 345–346.

Notes on the ore deposits of this region.

42 **Bryson** (John). Lake Ronkonkoma and other glacial features of Long Island [New York].

Am. Geol., vol. xiii, pp. 390–392.

Describes the depression in which this lake occurs and discusses the evidences bearing on the amount of elevation and subsidence the island has undergone during and since the Glacial period.

43 **Bush** (E. Renshaw). The Sudbury nickel region [Ontario].

Eng. and Mg. Jour., vol. lvii, pp. 245–246.

Describes the topography of the region, names the rock varieties in which the nickel and copper occurs, and describes the general occurrence of the nickeliferous pyrrhotite and chalcopyrite. Discusses the origin of the deposits.

C.

44 **Cadell** (H. M.). [Classification of Pleistocene deposits.]

Int. Cong. Geol., Compte Rendu, 5th session, p. 198 (¼ p.).

Describes glacial phenomena of Scotland.

44*a* **California, State Mining Bureau.** Eleventh Report of the State Mineralogist.

Abstract: Am. Nat., vol. xxviii, pp. 335–336 (½ p.).

Noticed in Bibliography and Index for 1892 and 1893.

45 **Call** (R. Ellsworth). On the induration of certain Tertiary rocks in northeastern Arkansas.

Ind. Acad. Sci., Proc., 1893, pp. 219–224, with map.

Describes the outcrops of sandstone in this region, hitherto referred to the Potsdam, but which the author considers to be Tertiary. Discusses the causes of the induration of these sandstones.

46 **Calvin** (Samuel). On the geological position of Bennettites dacotensis Macbride, with remarks on the stratigraphy of the region in which the species was discovered.

Am. Geol., vol. xiii, pp. 79–84; Iowa Acad. Sci., Proc., vol. i, pt. iv, pp. 18–22.

Describes the stratigraphic relations of the formations in the portion of the Black Hills in which Bennettites dacotensis were found and concludes that they represent the Dakota Cretaceous.

47 —— On a new horizon and some new localities for friable sandstone in which the grains are enlarged by secondary deposition of silica in optical continuity with the original nucleus.

Am. Geol., vol. xiii, pp. 225–227.

Describes sandstone beds associated with the Lower Magnesian limestone in Iowa, which are thought to be an equivalent of the New Richmond sandstone of Minnesota and Wisconsin.

48 **Calvin** (Samuel). The Niobrara chalk.

Am. Geol., vol. xiv, pp. 140–161.

Abstract: Jour. of Geol., vol. ii, pp. 755–756.

Describes the distribution and physical characters of the formation. Refers to the literature describing these beds and compares them with the chalk formation of England.

49 **Campbell** (Marius R.). Estillville folio. Virginia, Kentucky, Tennessee.

U. S. Geol. Surv., Geologic Atlas of the United States, folio 12.

Describes the physiography and drainage of the region, the character and occurrence of the Cambrian, Cambro-Silurian, Silurian, Devonian, and Carboniferous strata, and the geologic structure and the coal deposits included in the area of the sheet. Gives the section of several coal outcrops and a table of coal analyses. Includes topographic, colored areal geologic, economic geologic, and structure section maps and a sheet of columnar sections.

50 —— Paleozoic overlaps in Montgomery and Pulaski counties, Virginia.

Geol. Soc. Am., Bull., vol. v, pp. 171–190, pl. 4.

Abstract: Am. Geol., vol. xiii, pp. 147–148 (⅔ p.).

Describes the physical features and the stratigraphy of the Cambrian, Silurian, Devonian, and Carboniferous formations, and discusses the geologic structure of the region.

51 —— Tertiary changes in the drainage of southwestern Virginia.

Am. Jour. Sci., 3d ser., vol. xlviii, pp. 21–29, with map.

Describes the changes that have occurred in the drainage of this region and discusses the evidences indicating that they were caused by local orogenic rather than by epeirogenic movements.

51*a* —— Geology of the Big Stone Gap coal field of Virginia and Kentucky.

Abstract: Am. Geol., vol. xiv, pp. 392–393.

Noticed in Bibliography and Index for 1892 and 1893.

51*b* —— **Hayes** (C. W.) and. Geomorphology of the Southern Appalachians.

Nat. Geog. Mag., vol. vi, pp. 63–126, pls. 4–6.

See Hayes (C. W.) and Campbell (M. R.), No. 264.

51*c* **Canada, Geological Survey.** Annual Report for 1890–91, vol. v.

Abstracts: Am. Geol., vol. xiii, pp. 429–431; Am. Nat., vol. xxviii, p. 336 (7 l).

Noticed in Bibliography and Index for 1892 and 1893.

52 **Case** (E. C.). A geological reconnoissance in southwest Kansas and No Man's Land.

Kans. Univ. Quart., vol. ii, pp. 143–147.

Gives a brief description of the Triassic deposits of this region.

53 —— Traces of a glacier at Kansas City, Mo.

Kans. Univ. Quart., vol. ii, pp. 149–150.

Brief description of the evidences which indicate the former existence of a glacier in this vicinity.

53*a* **Case** (E. C.), **Williston** (S. W.) and. Kansas mosasaurs.
Kans. Univ. Quart., vol. i, pp. 15–32, pls. ii-vi.
See Williston (S. W.) and Case (E. C.), No. 649.

54 **Case** (William H.). The Bertha zinc mines at Bertha, Va.
Am. Inst. Mg. Engrs., Trans., vol. xxii, pp. 511–536.
Describes the geology of the region, presents a geologic map and cross section, and describes the character and occurrence of the ore and the methods of mining employed.

55 **Cazin** (F. M. F.). [The genesis of ore deposits.]
Am. Inst. Mg. Engrs., Trans., vol. xxiii, pp. 604–608.
In discussion of paper by F. Posepny on the same subject describes the character and structure of the ore bodies of the Vermont copper mines.

56 **Chamberlin** (Thomas C.). Pseudo-cols.
Jour. of Geol., vol. ii, pp. 205–206.
Abstract: Am. Geol., vol. xiii, p. 217 (¾ p.)
Discusses the use of the term col and describes the mode of formation of pseudo-cols.

57 —— Proposed genetic classification of Pleistocene glacial formations.
Jour. of Geol., vol. ii, pp. 517–538.
Describes the author's method of classifying the Pleistocene glacial formations, based on the origin of the formations.

58 —— Glacial studies in Greenland.
Jour. of Geol., vol. ii, pp. 649–666 and 768–788, figs. 1–14.
Gives an itinerary of the journey to Greenland and describes the characteristics of the glaciers examined.

59 —— [Drift fringe on Long Island, New York.]
Geol. Soc. Am., Bull., vol. v, p. 16 (⅜ p.).
In discussion of papers by A. A. Wright and E. H. Williams, jr., on glacial phenomena of New Jersey and Pennsylvania.

60 —— [Relation of deformation to ore deposition.]
Geol. Soc. Am., Bull., vol. v, p. 32 (⅛ p.).
In discussion of paper by W. P. Blake on the Wisconsin lead and zinc deposits.

61 —— [Formation of kames, eskers, and moraines.]
Geol. Soc. Am., Bull., vol. v, p. 85 (½ p.).
Discusses the character of the material of which kames, eskers, and moraines are formed.

62 —— [Classification of Pleistocene deposits.]
Int. Cong. Geol., Compte Rendu, 5th session, pp. 176–192 and 207 (⅛ p.).
Discusses the classification of Pleistocene glacial deposits, based upon the origin of the formations.

63 **Chamberlin** (Thomas C.) and **Leverett** (Frank). Further studies of the drainage features of the Upper Ohio Basin.

Am. Jour. Sci., 3d ser., vol. xlvii, pp. 247–283 and p. 483, four maps and five figures.

Abstract: Am. Geol., vol. xiii, pp. 217–219.

Describes the drainage features and erosion of the Upper Ohio tributaries, the old fluvial floors, drift, and terraces. Gives a summary statement of four hypotheses and describes and illustrates by diagrams the ratios of work done.

64 **Charleton** (A. G.). Nickel, its history, uses, and distribution.

Sci. Am. Suppl., vol. xxxvii, pp. 15418–15419.

Discusses the genesis of nickel.

65 **Chester** (Albert H.). Acanthite from Colorado.

School of Mines Quart., vol. xv, pp. 103–104.

Describes crystals of silver sulphide which are considered to belong to this species.

66 —— On caswellite, an altered biotite from Franklin Furnace, N. J. Quartz crystals from Ellenville, N. J.

N. Y. Acad. Sci., Trans., vol. xiii, pp. 181–184.

Describes the chemical and optical characters of a new mineral species, caswellite, and the crystallographic characters of quartz crystals.

67 **Church** (John A.). [Geological distribution of the useful metals in the United States.]

Am. Inst. Mg. Engrs., Trans., vol. xxii, pp. 732–735.

In discussion of paper by S. F. Emmons on the same subject.

68 —— [The genesis of ore deposits.]

Am. Inst. Mg. Engrs., Trans., vol. xxiii, pp. 593–597.

In discussion of paper on the same subject by F. Posepny.

69 **Clark** (William B.). Cretaceous and Tertiary geology.

N. J. Geol. Surv., Rept. for 1893, pp. 329–355.

Contains a general discussion, classification, and description of the formations and describes certain typical section lines across the Cretaceous and Tertiary beds.

70 —— Origin and classification of the greensands of New Jersey.

Jour. of Geol., vol. ii, pp. 161–177.

Abstract: Am. Geol., vol. xiii, p. 210 (⅓ p.).

Gives a sketch of the stratigraphic features, describes the several formations, and discusses the origin, genesis, and source of the materials of the greensands.

71 —— Climatology and physical features of Maryland.

Maryland State Weather Service, 1st Biennial Rept. for 1892–93, pp. 1–146.

Describes the topography, geologic formations, soils, and climate of Maryland.

71*a* **Clark** (William B.). The Mesozoic Echinodermata of the United States.

Abstract: Am. Geol., vol. xiv, pp. 329–330.
Noticed in Bibliography and Index for 1892 and 1893.

71*b* —— A preliminary report on the Cretaceous and Tertiary formations of New Jersey.

Abstract: Jour. of Geol., vol. ii, pp. 239–240.
Noticed in Bibliography and Index for 1892 and 1893.

71*c* —— **Williams** (George H.) and. Outline of the geology and physical features of Maryland.

Abstract: Am. Jour. Sci., 3d ser., vol. xlvii, p. 320 (½ p.).
See Williams (G. H.) and Clark (W. B.), No. 638.

72 **Clarke** (Frank W.). An occurrence of anorthite and epidote.

Am. Jour. Sci., 3d ser., vol. xlviii, p. 429 (communicated).
Describes the occurrence and chemical composition of these minerals, from Maine.

73 **Clarke** (John M.). Composite generic fundamenta.

Am. Geol., vol. xiii, pp. 286–289 (correspondence).
Describes the variations of the generic type of the genus Leptodesma occurring in Hamilton beds.

74 —— American species of Autodetus and some paramorphic shells from the Devonian.

Am. Geol., vol. xiii, pp. 327–335, figs. 1–13.
Reviews the nomenclature of the genus Autodetus and describes the new species Autodetus beecheri and lindstrœmi and Protocalyptræa styliophila and marshalli, found in the Devonian of New York.

75 —— The early stages of Bactrites.

Am. Geol., vol. xiv., pp. 37–43, pl. ii.
Describes some protoconch-bearing specimens of Bactrites from the Devonian of western New York.

76 —— Nanno, a new cephalopoden type.

Am. Geol., vol. xiv, pp. 205–208, pl. vi.
The material described was obtained from the Trenton shales of Minneapolis and the Galena shales at Chatfield, Minn.

77 —— The succession of the fossil faunas in the section of the Livonia salt shaft [New York].

N. Y. State Mus., 47th Ann. Rept., pp. 327–352.
Gives a list of fossils found in the Livonia salt shaft.

78 —— New or rare species of fossils from the horizons of the Livonia salt shaft [New York].

N. Y. State Mus., 47th Ann. Rept., pp. 355–383, pls. 1–4.
Describes a number of new and rare species from the Devonian found in the Livonia salt shaft.

79 —— Report on field work in Chenango County [N. Y.].

N. Y. State Mus., 47th Ann. Rept., pp. 725–751.
Describes the lithologic character and succession of the Devonian strata in this county and gives a résumé of the results obtained.

80 **Clarke** (John M.). A list of publications relating to the geology and paleontology of the State of New York, 1876–1893.
N. Y. State Mus., 47th Ann. Rept., pp. 755–791.

80*a* —— See **Hall** (J.) and **Clarke** (J. M.), Nos. 235–236*a*.

81 **Claypole** (E. W.). A new species of Carcinosoma.
Am. Geol., vol. xiii, pp. 77–79, pl. iv.
Describes Carcinosoma ingens n. sp. which was described as belonging to the genus Eurysoma in the December number, 1893, of the American Geologist.

82 —— Cladodus ? magnificus, a new selachian.
Am. Geol., vol. xiv, pp. 137–140, pl. v.
Describes a portion of a jaw found in the Cleveland shale, with remarks on the character of the Devonian fish fauna of Ohio.

83 —— On a new placoderm, Brontichthys clarki, from the Cleveland shale.
Am. Geol., vol. xiv, pp. 379–380, pl. xii.
Describes a new genus from the Cleveland shale of Ohio.

84 —— The fossil fishes of Ohio.
Ohio Geol. Surv., vol. vii, pp. 602–619.
Describes the characters of some fossil fishes and sharks from Ohio.

85 —— [Correlation of clastic rocks.]
Int. Cong. Geol., Compte Rendu, 5th session, pp. 166–167 (7 l.).
Remarks on the value of the different methods of geologic correlation.

86 **Cobb** (Collier). Note on the deflective effect of the earth's rotation as shown in streams.
Elisha Mitchell Sci. Soc., Jour., 1893, pp. 26–32.
Gives a map of a portion of North Carolina, describes its drainage systems, and considers that the effect of the earth's rotation is perceptible in this region.

87 —— On the geological history of certain topographical features east of the Blue Ridge.
Elisha Mitchell Sci. Soc., Jour., 1893, pp. 94–97.
Describes certain topographic forms of North Carolina which are considered to have been formed by wave action in post-Cretaceous time.

88 **Coleman** (A. P.). Antholite from Elzivir, Ontario.
Am. Jour. Sci., 3d ser., vol. xlviii, pp. 281–283.
Describes the chemical and physical characteristics of the mineral.

89 —— Inter-Glacial fossils from the Don Valley, Toronto.
Am. Geol., vol. xiii, pp. 85–93.
Describes the lithologic character of the glacial beds in this region, mentions some of the fossils found in them, and discusses the evidences as to the character of the glacial phenomena.

90 —— Notes on the geology of the Rocky Mountains between the Saskatchewan and the Athabasca.
Am. Geol., vol. xiv, pp. 83–92.
Abstract: Am. Nat., vol. xxviii, pp. 880–881.
Describes the topography and geology of a portion of the Rocky Mountains lying between the Saskatchewan and Athabasca rivers, and gives lists of fossils collected at different localities in this region.

91 **Comstock** (Theodore B.). Notes on Arizona mines. I. Silver.
Eng. and Mg. Jour., vol. lvii, p. 103.
Describes briefly the general character of the silver ores in Arizona.

92 **Cooper** (J. G.). On some Pliocene fresh-water fossils of California.
Cal. Acad. Sci., Proc., 2d ser., vol. iv, pp. 166–172, pl. 14.
Describes and figures Margaritana subangulata n. sp. and gives a list of Pliocene fossils found in the Kettelman, Asphalto, Contra Costa, Tassajara, and Santa Clara lake beds.

93 **Cope** (Edward D.). On the structure of the skull in the plesiosaurian Reptilia, and on two new species from the Upper Cretaceous.
Am. Phil. Soc., Proc., vol. xxxiii, pp. 109–113, pl. x.
Describes and figures the skull of Cimoliasaurus snovii Williston from the Niobrara Cretaceous of Kansas and Embaphias circulosus n. gen. et sp. and Elasmosaurus intermedias n. sp. from the Cretaceous of South Dakota.

94 —— Observations on the geology of adjacent parts of Oklahoma and northwest Texas.
Phil. Acad. Nat. Sci., Proc., 1894, pp. 63–68.
Includes brief notes on the Cretaceous of portions of North and South Dakota, on the Permian and Cretaceous of Oklahoma and adjacent portions of Texas, and on the Pleistocene in southeastern Kansas.

95 —— New and little-known Paleozoic and Mesozoic fishes.
Phil. Acad. Nat. Sci., Jour., 2d ser., vol. ix, pp. 427–448, pls. xviii–xx.
Describes two new genera and nine new species of fishes.

96 —— On Cyphornis, an extinct genus of birds.
Phil. Acad. Nat. Sci., Jour., 2d ser., vol. ix, pp. 449–452.
Describes the characters of a new genus found on Vancouver Island, which indicates that the clay bed in which it was found is of Eocene or Oligocene age.

97 —— Extinct Bovidæ, Canidæ, and Felidæ from the Pleistocene of the Plains.
Phil. Acad. Nat. Sci., Jour., 2d ser., vol. ix, pp. 453–459, pls. xxi–xxii.
Describes and figures a new species of Bovidæ and of Felidæ.

98 —— [Correlation of clastic rocks.]
Int. Cong. Geol., Compte Rendu, 5th session, p. 175 (⅛ p.).
Remarks on the value of vertebrates for purposes of correlation.

99 —— Scott on the Mammalia of the Deep River beds.
Am. Nat., vol. xxviii, pp. 790–791.
Reviews a paper by W. B. Scott on the Mammalia of the Deep River beds.

100 —— Marsh on Tertiary Artiodactyla.
Am. Nat., vol. xxviii, pp. 867–869.
Review of paper by O. C. Marsh.

101 **Cox** (Charles F.). Additional notes on recently discovered deposits of diatomaceous earth in the Adirondacks.
N. Y. Acad. Sci., Trans., vol. xiii, pp. 98–101.
Describes some recently discovered deposits in Herkimer County, N. Y.

102 **Cragin** (F. W.). New and little known Invertebrata from the Neocomian of Kansas.

Am. Geol., vol. xiv, pp. 1–12, pl. i.

Describes 17 new species from the Cretaceous of southern Kansas.

102*a* —— A contribution to the invertebrate paleontology of the Texas Cretaceous.

Review: Am. Geol., vol. xiii, p. 124 (½ p.).

Noticed in Bibliography and Index for 1892 and 1893.

102*b* **Crane** (Agnes). The evo'ution of Brachiopoda.

Abstract: Am. Geol., vol. xiii, p. 194 (½ p.).

Noticed in Bibliography and Index for 1892 and 1893.

103 **Crawford** (J. J.). Twelfth Report of the State Mineralogist.

Cal. State Mg. Bureau, 12th Rept., pp. 1–411.

Describes the occurrence of antimony, silver, lead, asphalt, bitumen, borax, chromic iron, coal, copper, gold, gypsum, iron, magnesite, manganese, natural gas, petroleum, quicksilver, building stones, asbestus, platinum, salt, soda, and zinc, in the various counties of California.

104 **Credner** (H.). [Classification of Pleistocene deposits.]

Int. Cong. Geol., Compte Rendu, 5th session, pp. 195 and 197.

Layers of sand between moraines are not to be considered as important criteria in chronologic classification, on account of their local character.

105 **Crosby** (W. O.). A classification of economic geological deposits based on origin and original structure.

Am. Geol., vol. xiii, pp. 249–268; Tech. Quart., vol. vii, pp. 27–48.

Discusses the general principles of classification and describes the author's system, based on the following primary divisions: (*a*) Deposits of igneous origin (igneous rocks). Heat is the chief agent. (*b*) Deposits of aqueo-igneous origin (pegmatite). Heat and water cooperate. (*c*) Deposits of aqueous origin (sedimentary and vein rocks). Water is the chief agent.

105*a* —— Geology of Boston Basin.

Abstracts: Am. Jour. Sci., 3d ser., vol. xlvii, p. 79 (7 l.); Am. Geol., vol. xiii, pp. 192–193 (½ p.).

Noticed in Bibliography and Index for 1892 and 1893.

105*b* —— Origin of the coarsely crystalline vein granites or pegmatites.

Abstract: Am. Geol., vol. xiii, pp. 215–216 (⅜ p.).

106 —— and **Ballard** (H. O.). Distribution and probable age of the fossil shells in the drumlins of the Boston Basin.

Am. Jour. Sci., 3d ser., vol. xlviii, pp. 486–496.

Gives a list of 55 species collected in the Boston Basin, describes the distribution, and concludes that they are of Glacial and post-Glacial origin and indicate a recession of the ice sheet in this region.

107 **Cross** (Whitman). The laccolitic mountain groups of Colorado, Utah, and Arizona.

U. S. Geol. Surv., 14th Ann. Rept., pt. 2, pp. 165–241, pls. vii–xvi, figs. 25–43.

Reviews the literature of the laccolitic theory. Describes the laccolites of the Henry, West Elk, San Miguel, La Plata, Carriso, El Late, Abajo, and La Sal mountains, Mosquito range, and the intrusive rocks of the Ten Mile district, Colorado. Discusses the chemical and mineralogic characters of laccolitic rocks, the conditions under which they were formed, and the forms and origin of laccolites.

108 —— Pikes Peak folio. Colorado.

U. S. Geol. Surv., Geologic Atlas of the United States, folio 7.

Describes the topographic features, the granite and metamorphic rocks, the occurrence and distribution of the Algonkian, Cambrian, Silurian, Carboniferous, Juratrias, Cretaceous, and Eocene strata. Describes the occurrence and petrographic characters of diabase, syenite, andesite, rhyolite, trachyte, phonolite, and the geographic distribution of the sedimentary and igneous formations and the structural development of the region. Includes a topographic, colored areal geologic, economic geologic, and structure section maps.

109 —— Description of the igneous formations [Anthracite-Crested Butte folio, Colorado].

U. S. Geol. Surv., Geologic Atlas of the United States, folio 9.

Describes the character and occurrence of diorite, porphyrite, porphyritic diorite, granite, rhyolite, and basalt, in the portion of Colorado included within the district named.

110 —— Intrusive sandstone dikes in granite.

Geol. Soc. Am., Bull., vol. v, pp. 225–230, pl. 8.

Abstracts: Am. Jour. Sci., 3d ser., vol. xlvii, p. 142 (7 l.); Am. Geol., vol. xiii, p. 215 (8 l.); Am. Nat., vol. xxviii, pp. 412–413.

Describes the portion of Colorado in which the dikes occur, their characteristics and mode of occurrence. Describes the dike rock and discusses the origin of dikes.

111 —— Itinerary, Nathrop to Salida, Colo.

Int. Cong. Geol., Compte Rendu, 5th session, pp. 423–424.

Describes the geology along the railroad between these points.

112 —— Manitou. Itinerary, Colorado Springs to Denver. Excursion to Morrison. Excursion to Golden [Colo.].

Int. Cong. Geol., Compte Rendu, 5th session, pp. 430–442.

Describes the geology of the Pikes Peak region, the geology of the Denver Basin, and the character of the Juratrias and Cretaceous beds at Morrison and Golden, Colo.

113 **Cubberly** (E. P.). Indiana's structural features as revealed by the drill.

Ind. Dept. Geol. and Nat. Res., 18th Rept., pp. 219–255, with map and 16 colored geologic sections.

Each geologic section is accompanied by a table showing the depth of the well, the formations penetrated, and other data on which the sections are based.

114 **Culver** (G. E.). Some New Jersey eskers.

Science, vol. xxiii, pp. 15–16.

Describes the character of certain eskers in northeastern New Jersey.

115 —— Note on the geology of Itasca County, Minn.

Minn. Geol. and Nat. Hist. Surv., 22d Ann. Rept., pp. 97–114.

Describes the topography of the region and the megascopic characters of the granite, diorite, and greenstones, and the glacial phenomena.

116 **Cunningham** (K. M.). Diatomaceæ.

Ala. Geol. Surv., Rept., on the geology of the Coastal Plain of Alabama, pp. 61–65.

Notes on the fossil Diatomaceæ of Alabama and a list of diatoms occurring at Montgomery.

117 —— Notes on the Microzoa of the Tertiary of south Alabama.

Ala. Geol. Surv., Rept., on the geology of the Coastal Plain of Alabama, pp. 250–254.

Notes on the occurrence of Microzoa in Alabama.

118 —— Notes on the micro-geology of Alabama Cretaceous.

Ala. Geol. Surv., Rept., on the geology of the Coastal Plain of Alabama, pp. 286–289.

Notes on the Cretaceous chalk formation.

119 **Cushing** (H. P.). Preliminary report on the geology of Clinton County, N. Y.

N. Y. State Mus., 47th Ann. Rept., pp. 669–683, with map.

Describes the character and distribution of the pre-Cambrian, Cambrian, and Silurian rocks of this county.

D.

120 **Dale** (T. Nelson). On the structure of the ridge between the Taconic and Green Mountain ranges in Vermont.

U. S. Geol. Surv., 14th Ann. Rept., pt. 2, pp. 525–549, pls. lxvi–lxx, figs. 54–64.

Describes the petrographic, paleontologic, and structural features of the Clarendon, Wallingford, Danby, and Pine Hill sections and gives a general résumé of the evidence showing the structure of the range and age of the formation.

121——The structure of Monument Mountain, in Great Barrington, Mass.

U. S. Geol. Surv., 14th Ann. Rept., pt. 2, pp. 551–565, pls. lxxi–lxxii, figs. 65–72.

Describes the petrographic character of the Berkshire schist and reviews the evidence indicating the geologic structure of the mountain.

122——Mount Greylock: its areal and structural geology.

U. S. Geol. Surv., Mon. xxiii, pp. 119–203, pls. xii–xxiii, figs. 30–79.

Gives a list of publications on the geology of the region. Describes the geologic structure of the region, and the lithologic and petrographic characters of the Cambrian and pre-Cambrian rocks.

122*a* **Dale** (T. Nelson). The Rensselaer grit plateau in New York.

Abstract: Am. Geol., vol. xiv, pp. 54–55.

Noticed in Bibliography and Index for 1892 and 1893.

123 **Dall** (William Healey). Notes on the Miocene and Pliocene of Gay Head, Marthas Vineyard, Mass., and on the "Land Phosphate" of the Ashley River district, South Carolina.

Am. Jour. Sci., 3d ser., vol. xlviii, pp. 296–301.

Gives a list of Miocene and Pliocene fossils identified from Gay Head and Chilmark, and describes two new species. Reviews the evidences of the age of the phosphate rock of the Ashley River district and concludes that the fauna are of Miocene facies.

123*a* —— Notes on the Atlantic Miocene.

Abstract: Am. Geol., vol. xiv, p. 202 (¼ p.).

124 —— On the species of Mactra from California.

Nautilus, vol. vii, pp. 136–138.

Describes three species, including one new species, from the coast of California.

125 —— and **Stanley-Brown** (J.). Cenozoic geology along the Apalachicola River.

Geol. Soc. Am., Bull., vol. v, pp. 147–170, pl. 3.

Abstract: Am. Geol., vol. xiii, pp. 137–138 (½ p.).

Describes in detail the geology of the localities studied and the geologic structure and succession of the Eocene, Miocene, Pliocene, and Pleistocene beds of this region.

126 **Dana** (James D.). Observations on the derivation and homologies of some articulates.

Am. Jour. Sci., 3d ser., vol. xlvii, pp. 325–329; Annals and Mag. Nat. Hist., vol. xiii, pp. 502–506.

Discusses the derivation of limaloids, crustaceans, arachnids, myrapods, and insects, and in a table shows the relations in body-segments and limbs between these classes.

127 **Darton** (Nelson Horatio). Shawangunk Mountain.

Nat. Geog. Mag., vol. vi, pp. 23–34, pls. 1–3, figs. 1–3.

Abstracts: Sci. Am. Suppl., vol. xxxvii, pp. 15284–15285; Am. Jour. Sci., 3d ser., vol. xlvii, p. 482 (7 l.).

Describes the relations of the Shawangunk grit and the underlying Hudson shales and the character and distribution of the lakes, which are considered to have been formed by glacial action.

128 —— Report on the relations of the Helderberg limestones and associated formations in eastern New York.

N. Y. State Mus., 47th Ann. Rept., pp. 393–422, pls. 1–4, figs. 1–5.

Describes the physiography of the region studied, presents several stratigraphic sections of Upper Silurian strata of central and eastern New York, and describes the lithologic character and succession of the deposits.

129 —— Preliminary report on the geology of Albany County [N. Y.].

N. Y. State Mus., 47th Ann. Rept., pp. 425–455, pls. 1–6, figs. 1–9.

Describes the physiographic features of the county and the lithologic character and stratigraphic relations of the Devonian and Silurian deposits, and includes notes on the Pleistocene geology.

130 **Darton** (Nelson Horatio). Preliminary report on the geology of Ulster County [N. Y.].

N. Y. State Mus., 47th Ann. Rept., pp. 485–566, pls. 1–23, figs. 1–18.

Describes the physiography of the region, the structural relations and the lithologic character and succession of the several members of the Devonian and Silurian formations represented in this county.

131 —— Geology of the Mohawk Valley in Herkimer, Fulton, Montgomery, and Saratoga counties [N. Y.].

N. Y. State Mus., 47th Ann. Rept., pp. 604–623, pls. 1–14.

Describes the exposures of Potsdam sandstone, Calciferous, Birdseye, Black River, and Trenton limestones and Utica shales in the Mohawk Valley of the counties named.

132 —— Geologic relations from Green Pond, New Jersey, to Skunnemunk Mountain, New York.

Geol. Soc. Am., Bull., vol. v, pp. 367–394, pl. xvii.

Abstract: Am. Geol., vol. xiii, pp. 211–212.

Reviews the literature on the geology and describes the Devonian, Silurian, and Cambrian beds of this region. Discusses the structure and gives a sketch of its geologic history.

133 —— Outline of Cenozoic history of a portion of the middle Atlantic slope.

Jour. of Geol., vol. ii, pp. 568–587.

Describes the physiographic features of the Piedmont and Coastal Plain areas in this region, the trenching of the Tertiary baselevel of the Piedmont Plateau, and the character of the Tertiary and Pleistocene deposits, and includes a résumé of the geologic history of the region in Cenozoic time.

134 —— Staunton folio. Virginia, West Virginia.

U. S. Geol, Surv., Geologic Atlas of the United States, folio 14.

Describes the physiographic subdivisions of the Appalachian province, the character and relations of the Cambrian, Silurian, Devonian, and Carboniferous formations, and the geologic structure and mineral resources of the region, including iron, marble, and clays. Includes a topographic, colored areal geologic, economic, and structure section maps and a columnar section.

134*a* —— **McGee**, (W J), **Williams**, (G. H.), **Willis**, (B.), and. Geology of Washington and vicinity.

Int. Cong. Geol., Compte Rendu, 5th sesion, pp. 219–251.

See McGee (W J), Williams (G. H.), Willis (B.), and Darton (N. H.), No. 385.

135 **Davis** (William Morris). Physical geography in the university.

Jour. of Geol., vol.ii, pp. 66–100.

Presents the plan of the author's course in physical geography.

136 —— [Remarks on drumlins.]

Bost. Soc. Nat. Hist., Proc., vol. xxvi, pp. 17–23.

Reviews the paper by W. Upham on the "Origin of drumlins."

137 **Davis** (William Morris). Facetted pebbles on Cape Cod, Massachusetts.

Bost. Soc. Nat. Hist., Proc., vol. xxvi, pp. 166–175, pls. i–ii.

Abstract: Am. Geol., vol. xiii, pp. 146–147.

Describes the occurrence of these pebbles on Cape Cod and discusses the evidences indicating that the beds in which they are found are subaerial deposits. Discusses the relation of facetting to rock structure and the post-Glacial changes of level in this region.

138 —— [Correlation of clastic rocks.]

Int. Cong. Geol., Compte Rendu, 5th session, p. 166 ($\frac{1}{5}$ p.).

Remarks on the correlation of rocks as indicated by degradation processes.

139 —— and **Griswold** (L. S.). Eastern boundary of the Connecticut Triassic.

Geol. Soc. Am., Bull., vol. v, pp. 515–530.

Abstracts: Jour. of Geol. vol. ii, pp. 644–645; Am. Geol., vol. xiii, pp. 145–146; Am. Jour. Sci., 3d ser., vol. xlvii, pp. 136–137.

Describes the geologic history of the region and discusses the general characteristics of faults. Discusses the evidences of faulting along the boundary of the Connecticut Triassic and gives the authors' conclusions.

140 **Dawson** (George M.). Geological notes on some of the coasts and islands of Bering Sea and vicinity.

Geol. Soc. Am., Bull., vol. v, pp. 117–146.

Abstracts: Am. Jour. Sci., 3d ser., vol. xlvii, p. 136 ($\frac{1}{3}$ p.); Am. Geol. vol. xiii, p. 137 ($\frac{1}{2}$ p.).

Contains notes on the topography and geology of the islands of Bering Sea.

141 —— Notes on the occurrence of mammoth remains in the Yukon district of Canada and Alaska.

Geol. Soc. London, Quart. Jour., vol. l, pp. 1–8.

Abstract: Can. Rec. Sci., vol. vi, p. 59 ($\frac{2}{3}$ p.).

Gives a historical sketch of the discoveries of mammoth remains in this region. Describes the unglaciated area in Alaska in which these remains occur and the Cordilleran glacier. Discusses the evidences of elevation and subsidence.

142 —— Volcanic rocks of the Huronian.

Science, vol. xxiii, p. 50.

Brief note on the occurrence of volcanic rocks in the vicinity of the Lake of the Woods.

142*a* —— Notes on the geology of Middleton Island, Alaska.

Abstract: Can. Rec. Sci., vol. vi, p. 58 ($\frac{1}{2}$ p.).

Noticed in Bibliography and Index for 1892 and 1893.

143 **Dawson** (J. William). Preliminary note on recent discoveries of batrachians and other air-breathers in the coal formation of Nova Scotia.

Can. Rec. Sci., vol. vi, pp. 1–7.

Abstract: Am. Geol., vol. xiii, p. 137 ($\frac{1}{3}$ p.).

Refers to the previous discoveries of animal remains in the coal beds of South Joggins. Gives the vertical section of an embedded tree recently found in these deposits, and mentions the fossils found in it.

144 **Dawson** (J. William). Our record of Canadian earthquakes.

Can. Rec. Sci., vol. vi, pp. 8–16.

Gives a list of publications of the records of Canadian earthquakes prior to 1877, and includes a list and description of earthquakes occurring since that time.

145 —— Note on the genus Naiadites, as occurring in the coal formation of Nova Scotia.

Geol. Soc. London, Quart. Jour., vol. l, pp. 435–437, pl. xx.

Describes the occurrence of this genus and its associates in the coal deposits of Nova Scotia.

146 —— The study of fossil plants.

Geol. Soc. Am., Bull., vol. v, pp. 2–5.

Discusses the importance of fossil plants as an aid in determining the geologic age of rocks and climatic conditions.

147 —— Some recent discussions in geology.

Geol. Soc. Am., Bull., vol. v, pp. 101–116.

Abstracts: Am. Geol., vol. xiii, pp. 135–137; Am. Jour. Sci., 3d ser., vol. xlvii, pp. 135–136.

Discusses the correlation of the Cambrian rocks of North America and Great Britain, the forces that have produced mountain ranges, uniformitarianism, the formation of coal, the relation of vegetation to continental movements, the phenomena of the Glacial period, and post-Pleistocene continental movements.

147*a* —— The Canadian Ice age.

William V. Dawson, Montreal, 1893.

Review: Jour. of Geol., vol. ii, pp. 232–235, by T. C. Chamberlin.

Abstracts: Am. Jour. Sci., 3d ser., vol. xlvii, pp. 146–147 (½ p.); Am. Geol., vol. xiii, pp. 116–121; Can. Rec. Sci., vol. vi, pp. 113–115.

148 **Dean** (Bashford). Contributions to the anatomy of Dinichthys.

N. Y. Acad. Sci., Trans., vol. xii, p. 187.

Abstract: Am. Geol., vol. xiii, pp. 357–358 (8 l.).

149 —— A new cladodont from the Ohio Waverly, Cladoselache newberryi n. sp.

N. Y. Acad. Sci., Trans., vol. xiii, pp. 115–118, pl. 1.

Describes and figures specimens from the sub-Carboniferous of Ohio.

150 —— Contributions to the morphology of Cladoselache (Cladodus).

Jour. of Morph., vol. ix, pp. 87–114, pl. vii.

Suggests the name Cladoselache for that of Cladodus for the American form. Discusses the relationships under the different structural characters.

151 **DeKalb** (Courtenay). The new gold fields of the Mosquito coast of Nicaragua.

Eng. and Mg. Jour., vol. lvii, pp. 294–295.

The gold occurs in placers in the Matagalpa Mountains, of small extent but very rich, and in "pockets." The mountains are said to be flanked by Carboniferous limestones overlain by Permian red sandstones and shales which have been covered by diorite flows, and the gold occurs along the contact of the shales and diorite mass.

152 **Diener** (C.). [Classification of Pleistocene deposits.]

Int. Cong. Geol., Compte Rendu, 5th session, p. 197 (⅕ p.).

Considers that fossil remains are not proof of the nonexistence of glaciers in the vicinity in which the fossils occur.

153 **Diller** (Joseph Silas). Tertiary revolution in the topography of the Pacific Coast.

U. S. Geol. Surv., 14th Ann. Rept., pt. 2, pp. 397-434, pls. xl-xlvii, figs. 45-48; Jour. of Geol., vol. ii, pp. 32-54.

Abstract: Am. Geol., vol. xiii, p. 354 (⅓ p.).

Describes the topography of the Pacific Coast, the ancient baselevel of erosion in northern California, and the character of the deposits upon its borders. Discusses the evidence as to the age of the baseleveling, the conditions during Cretaceous, Eocene, and Miocene times, and the deformation of the baselevel.

154 —— and **Schuchert** (Charles). Discovery of Devonian rocks in California.

Am. Jour. Sci., 3d ser., vol. xlvii, pp. 416-422.

Abstract: Am. Nat., vol. xxviii, p. 796 (⅓ p.).

Describes the different outcrops of Devonian rocks that have been found in California, with notes on the fossils collected from them, and discusses their correlation with Devonian strata of other regions.

155 —— and **Stanton** (T. W.). The Shasta-Chico series.

Geol. Soc. Am., Bull., vol. v, pp. 435-464.

Abstracts: Am. Jour. Sci., 3d ser., vol. xlvii, p. 141 (⅕ p.); Am. Geol., vol. xiii, p. 208 (6 l.); Am. Nat., vol. xxviii, p. 1024 (⅔ p.).

Reviews the literature of the Cretaceous deposits of the Pacific Coast. Describes three sections of the Cretaceous deposits and gives lists of fossils found at different horizons. Discusses the faunal relations of the beds, the deformation during and subsequent to their deposition, and the correlation of the series with the Cretaceous of other parts of North America.

156 **Dodge** (R. E.). The geographical development of alluvial river terraces.

Bost. Soc. Nat. Hist., Proc., vol. xxvi, pp. 257-273.

Abstract: Am. Geol., vol. xiv, p. 397 (½ p.).

Describes the formation of alluvial terraces and plains, the cycle and development of a normal river, and normal, subnormal, and accidental alluvial terraces. Discusses the conditions of terrace formation and gives the author's conclusions.

157 —— Additional species of Pleistocene fossils from Winthrop, Mass.

Am. Jour. Sci., 3d ser., vol. xlvii, pp. 100-104.

Mentions the species heretofore found in a drumlin in Boston Harbor, and also others recently found by the author. Considers that ocean waters were warmer both prior and subsequent to the advance of the ice sheet, and discusses the causes of this phenomenon.

158 —— Continental phenomena illustrated by ripple marks.

Science, vol. xxiii, pp. 38-39.

Describes ripple marks occurring on the coast of Massachusetts, which are compared to the formation of a continental shelf similar to that along the eastern coast of North America.

159 **Dryer** (Charles R.). The geology of Noble County [Ind.].

Ind. Dept. Geol. and Nat. Res., 18th Rept., pp. 17–32.

Describes the glacial deposits of the county and gives the sections displayed by several artesian wells, showing the presence of Devonian and Silurian strata.

160 —— Report upon the geology of Lagrange County [Ind.].

Ind. Dept. Geol. and Nat. Res., 18th Rept., pp. 72–82.

Describes the character and distribution of the glacial beds of the county.

161 —— The drift of the Wabash-Erie region. A summary of results.

Ind. Dept. Geol. and Nat. Res., 18th Rept., pp. 83–90.

Describes the distribution of the moraines and the movements of the ice sheet in this region.

162 **Dumble** (E. T.). The Cenozoic deposits of Texas.

Jour. of Geol., vol. ii, pp. 549–567.

Describes the lithologic character of the Cenozoic deposits of Texas and gives lists of fossils found at different horizons and localities.

163 **Dunn** (R. L.). Auriferous conglomerate in California.

Cal. State Mg. Bureau, 12th Rept., pp. 459–471, with map.

Describes an auriferous conglomerate of peculiar character occurring in Siskiyou County. Discusses the evidences bearing on its fluviatile origin and on the source of the gold. Compares this deposit with the auriferous conglomerate of South Africa.

E.

164 **Eakle** (A. S.). On allanite crystals from Franklin Furnace, N. J.

Am. Jour. Sci., 3d ser., vol. xlvii, pp. 436–439; N. Y. Acad. Sci., Trans., vol. xiii, pp. 102–107.

Abstract: Am. Nat., vol. xxviii, p. 877 (6 l.).

Describes the crystallographic characters of crystals from the Trotter mine.

165 **Eastman** (Charles R.). Beiträge zur Kenntniss der Gattung Oxyrhina, mit besonderer Berücksichtigung von Oxyrhina mantelli Agassiz.

Paleontographica, Band xli, pp. 149–192, pls. xvi–xviii.

Describes Oxyrhina mantelli from the Cretaceous of Kansas and gives a summary of the species of Oxyrhina.

166 **Eldridge** (George H.). Description of the sedimentary formations [Anthracite-Crested Butte folio, Colorado.]

U. S. Geol. Surv., Geologic Atlas of the United States, folio 9.

Describes the Archean, Cambrian, Silurian, Carboniferous, Jura-trias, and Cretaceous formations of the region, the geologic structure and the occurrence of coal in the Laramie, and gives four tables of analyses of the coals.

167 —— A geological reconnoissance in northwest Wyoming.

U. S. Geol. Surv., Bull., No. 119, 72 pp., pls. i–iv, fig. 1.

Describes the topography of the Big Horn Mountain region, the general character of the Archean, Cambrian, Silurian, Carboniferous, Trias, Jura, Cretaceous, and Tertiary formations, the structure of the mountain ranges, and the occurrence of coal, petroleum, building materials, and gold.

168 **Eldridge** (George H.). Artesian wells of eastern Dakota.

Int. Cong. Geol., Compte Rendu, 5th session, p. 318.

Describes the character of the strata from which artesian water is obtained and gives the depths of the wells.

169 **Elftman** (Arthur Hugo). Preliminary report of field work during 1893 in northeastern Minnesota.

Minn. Geol. and Nat. Hist. Surv., 22d Ann. Rept., pp. 141–180.

Describes the topography of portions of Lake County and the distribution and petrographic characters of the granite, actinolite-magnetite schist, gabbro, red rock, diabase, and anorthosyte of northeastern Minnesota.

170 **Ells** (R. W.). Mica deposits in the Laurentian of the Ottawa district.

Geol. Soc. Am., Bull., vol. v, pp. 481–488.

Abstract: Am. Geol., vol. xiii, p. 215 (6 l.).

Describes the metamorphosed sedimentaries and intrusive rocks of this district, the occurrence of apatite and mica, and the differences in the mica-apatite deposits.

171 **Emmons** (Samuel Franklin). Description of the Elk Mountains [Anthracite-Crested Butte folio, Colorado].

U. S. Geol. Surv., Geologic Atlas of the United States, folio 9.

Gives a historical sketch of the geology of the region and describes the clays, iron ore, and precious metal deposits. Includes a topographic, colored geologic, economic, and structure section maps of each of the districts and a sheet of columnar sections.

172 —— Geological distribution of the useful metals in the United States.

Am. Inst. Mg. Engrs., Trans., vol. xxii, pp. 53–95 and 737–738.

Describes the geologic occurrence in different parts of the United States of iron, manganese, nickel, tin, copper, lead, zinc, quicksilver, gold, and silver, and gives a summary of conclusions concerning the genesis of their minerals.

173 —— [The genesis of ore deposits.]

Am. Inst. Mg. Engrs., Trans., vol. xxiii, pp. 597–602.

Discussion of paper by F. Posepny on the same subject.

174 —— Congrès Géologique International, Compte Rendu de la 5me session, Washington, 1891, ix + 529 pp., pls. i–xxi, figs. 1–39. Edited by S. F. Emmons, secretary.

Contains a historical sketch of the Congress, report of the sessions, a description of the geology of Washington and vicinity, the geology of the region traversed by the excursion to the Rocky Mountains and the Grand Canyon of the Colorado, and of the excursion to Lake Superior.

174*a* —— Guidebook of an excursion to the Rocky Mountains.

John Wiley & Sons, 1894, New York.

Describes the geology along the route traversed by the western excursion of the International Congress of Geologists from Washington, D. C., to Chicago, St. Paul, Yellowstone National Park, Snake Plains, Great Salt Lake, Leadville, Denver, Canyon of the Colorado, Kansas City, Chicago, Niagara Falls, and to New York City.

Extract from Compte Rendu, Int. Cong. Geol., 5th session.

175 **Emmons** (Samuel Franklin). From Chicago to the Mississippi River. Itinerary.

Int. Cong. Geol., Compte Rendu, 5th session, pp. 298–301.

Describes the glacial phenomena of the region and the outcrops of the Cambrian beds.

176 —— Livingston to the Snake Plains. Itinerary. Butte City to Pocatello. The Snake Plains.

Int. Cong. Geol., Compte Rendu, 5th session, pp. 367–374.

Describes the geology along the route of travel of the excursion of the International Congress of Geologists in this region and the geologic history of the Snake Plains.

177 —— The Wasatch Mountains and the geological panorama of the Wasatch range.

Int. Cong. Geol., Compte Rendu, 5th session, pp. 381–391.

Describes the geologic history of this range, the outcrops of the strata, and the structure of the mountain range.

178 —— Itinerary. Spanish Fork Canyon, Utah, to Grand Junction, Colo.

Int. Cong. Geol., Compte Rendu, 5th session, pp. 397–402.

Describes the geology along the railroad between the points named.

179 —— The Rocky Mountains of Colorado. Itinerary, Grand Junction to Glenwood Springs and Aspen, Glenwood Springs to Leadville and Nathrop, and Salida to Canyon City, Colo.

Int. Cong. Geol., Compte Rendu, 5th session, pp. 403–426.

Describes the geologic history and general structure of the Rocky Mountains and the local geology along the railroad between the points mentioned.

180 —— Itinerary, Canyon City to Colorado Springs [Colo.].

Int. Cong. Geol., Compte Rendu, 5th session, pp. 428–429.

Describes the geology along the railroad between these points.

181 —— The Great Plains of Colorado and Kansas. Itinerary, Denver to Kansas City.

Int. Cong. Geol., Compte Rendu, 5th session, pp. 443–448.

Describes the geologic features of the Great Plains and the local geology along the route traversed by the excursion.

182 —— Excursion to the Canyon of the Colorado. Itinerary, Denver, Colo., to Albuquerque, N. Mex.

Int. Cong. Geol., Compte Rendu, 5th session, pp. 464–468.

Describes the local geology along the route traversed.

183 —— Bibliography of the geology of the excursion to the Rocky Mountains.

Int. Cong. Geol., Compte Rendu, 5th session, pp. 482–487.

Gives a list of 123 publications relating to the geology along the route traversed by the western excursion of the International Congress of Geologists.

184 **Emmons** (Samuel Franklin) and **Merrill** (G. P.). Geological sketch of Lower California.

Geol. Soc. Am., Bull., vol. v, pp. 489–514, pl. 19.

Abstract: Am. Geol., vol. xiii, pp. 209–210.

Describes the physical features and reviews previous descriptions of the geology of Lower California. Describes the general structure and the occurrence of Eocene and Cretaceous beds, and gives a list of fossils found at different horizons.

185 **Eyerman** (John). Vertebrate paleontology at the Columbian Exposition; a brief notice.

Am. Geol., vol. xiii, pp. 47–48.

Mentions the genera and species of vertebrates from various countries exhibited at the World's Columbian Exposition.

186 —— Preliminary notice of a new species of Temnocyon and a new genus from the John Day Miocene of Oregon.

Am. Geol., vol. xiv, pp. 320–321.

Gives a brief description of the new species and of a new genus, Hypotemnodon.

F.

186*a* **Faber** (C. L.), **Miller** (S. A.) and. New species of fossils from the Hudson River group, and remarks upon others.

Cin. Soc. Nat. Hist., Jour., vol. xvii, pp. 22–33.

See Miller (S. A.) and Faber (C. L.], No. 414.

186*b* —— Description of some Cincinnati fossils.

Cin. Soc. Nat. Hist., Jour., vol. xvii, pp. 137–158.

See Miller (S. A.) and Faber (C. L.), No. 415.

187 **Fairbanks** (H. W.). Red Rock, Goler, and Summit mining districts, in Kern County [Cal.].

Cal. State Mg. Bureau, 12th Rept., pp. 456–458.

Describes the occurrence of gold in the wash from the conglomerate and sedimentary strata of this region.

188 —— Preliminary report on the mineral deposits of Inyo, Mono, and Alpine counties [Cal.].

Cal. State Mg. Bureau, 12th Rept., pp. 472–478.

Describes the topography and mineral resources of these counties in southeastern California.

189 —— Geology of a section of Eldorado County [Cal.].

Cal. State Mg. Bureau, 12th Rept., pp. 479–481.

Describes the gold-quartz veins of a portion of this county separated from the "mother lode" by a diabase ridge.

190 —— Geology of northern Ventura, Santa Barbara, San Luis Obispo, Monterey, and San Benito counties [Cal.].

Cal. State Mg. Bureau, 12th Rept., pp. 493–526.

Describes the pre-Cretaceous, Cretaceous, and Miocene beds of these counties and gives the author's summary of conclusions.

191 **Fairbanks** (H. W.). Notes on some localities of Mesozoic and Paleozoic in Shasta county, Cal.

Am. Geol., vol. xiv, pp. 25–31.

Describes the geologic structure, lithologic character, and fauna of the Jurassic, Triassic, Carboniferous, and Devonian strata found in this region.

192 —— A remarkable folded vein in the Ready Relief Mine [Cal.].

Eng. and Mg. Jour., vol. lvii, pp. 321–322.

Describes the apparent folding of mica-schist and gneiss in the Peninsula range of San Diego County, Cal., and discusses the cause of the phenomenon.

193 —— Some remarkable hot springs and associated mineral deposits in Colusa County, Cal.

Science, vol. xxiii, pp. 120–121.

Describes the occurrence of hot springs and the associated gold and quicksilver deposits in this county.

194 **Fairchild** (Herman Le Roy). The evolution of the ungulate mammals.

Abstract: Roch. Acad. Sci., Proc., vol. ii, pp. 206–209.

Describes the evolution of the Artiodactyla and Perissodactyla.

195 —— The geological history of Rochester, N. Y.

Roch. Acad. Sci., Proc., vol. ii, pp. 215–223.

Gives a condensed section of the strata at Rochester and describes the process of deposition in Silurian and Devonian times and the character of the Glacial deposits.

196 —— The length of geologic time.

Roch. Acad. Sci., Proc., vol. ii, pp. 263–266.

Reviews the recent literature on the subject and gives the estimates of different writers.

197 **Foerste** (Aug. F.). Fossils of the Clinton group in Ohio and Indiana.

Ohio Geol. Surv., vol. vii, pp. 516–601.

Describes fossils found in Clinton rocks of these States, including several new species.

198 —— The Upper Vicksburg Eocene and the Chattahoochee Miocene of southwest Georgia and adjacent Florida.

Am. Jour. Sci., 3d ser., vol. xlviii, pp. 41–54, with sketch map.

Describes certain exposures of the Eocene and Miocene in this region and correlates them with other deposits of Georgia.

199 **Fogh** (Carl S.). Some geological features of the mine of Velardena, Mexico.

Eng. and Mg. Jour., vol. lvii, pp. 29–30.

Describes the ore bodies and the dikes which cut them.

200 **Fontaine** (William Morris). Notes on some fossil plants from the Trinity division of the Comanche series of Texas.

U. S. Nat. Mus., Proc., vol. xvi, pp. 261-282, pls. xxxvi–xliii.

Discusses the lithologic character of the bed in which the fossils were found and the characteristics of the plants collected, including eight new species.

201 **Frazer** (Persifor). The sixth session of the International Congress of Geologists.

Am. Geol., vol. xiv, pp. 259–271.

Gives an account of the excursions and proceedings of this session held at Zurich, Switzerland, in August, 1894.

202 —— [On the red horizons.]

Am. Phil. Soc., Proc., vol. xxxiii, pp. 216–217.

Discusses a paper by B. S. Lyman on the same subject.

203 **Frech** (F.). [Correlation of clastic rocks.]

Int. Cong. Geol., Compte Rendu, 5th session, pp. 171–172 (½ p.).

Remarks on the comparison of the middle Paleozoic faunas of Europe and North America.

204 —— Section in Congress Canyon opposite Point Sublime [Ariz.].

Int. Cong. Geol., Compte Rendu, 5th session, pp. 476–481.

Describes exposures of Archean, Algonkian, Cambrian, and Carboniferous rocks in this canyon, and gives the author's conclusions.

205 **Fultz** (Francis M.). Interruption during the deposition of the Burlington limestone.

Am. Geol., vol. xiv, pp. 246–249.

Discusses the evidences of disturbances during the Burlington epoch in the Mississippi Valley.

206 —— Evidences of disturbance during the deposition of the Burlington limestones.

Iowa Acad. Sci., Proc., vol. i, pt. iv, pp. 56–58.

Discusses the disturbances occurring in the Burlington limestone as indicated by changes in fossil forms, lithologic characters, erosion, and unconformability.

G.

207 **Gaudry** (A.). [Classification of Pleistocene deposits.]

Int. Cong. Geol., Compte Rendu, 5th session, pp. 192–193.

Remarks on the desirability of a chronological classification of Pleistocene deposits.

208 **Geer** (Gerard de). [Correlation of clastic rocks.]

Int. Cong. Geol., Compte Rendu, 5th session, pp. 155–156 (½ p.).

Remarks on statistical analyses of fossil faunas, with special reference to the number of individuals found.

209 —— [Classification of Pleistocene deposits.]

Int. Cong. Geol., Compte Rendu, 5th session, pp. 193–194, 196 and 198.

Remarks on the importance of a genetic classification of Pleistocene deposits and the possibility of a local chronologic classification.

209*a* **Geikie** (Archibald). Text Book of Geology, third edition.

Macmillan & Co., London and New York, 1893.

Review: Am. Geol., vol. xiii, pp. 66–70.

209*b* **Geikie** (James). The great Ice age.

Third edition, London, Edward Stanford.

Review: Jour. of Geol., vol. ii, pp. 730–747, by R. D. Salisbury.

209*c* **Gibson** (A. M.). Report on the coal measures of Blount Mountain.
Abstracts: Am. Jour. Sci., 3d ser., vol. xlvii, p. 319 (8 l.); Am. Geol., vol. xiii, p. 284 ($\frac{1}{8}$ p.).
Noticed in Bibliography and Index for 1892 and 1893.

210 **Gilbert** (Grove Karl). [Correlation of clastic rocks.]
Int. Cong. Geol., Compte Rendu, 5th session, pp. 151–155.
Discusses the physical and biotic methods of correlation of rocks.

211 —— Physical geography of the region.
Int. Cong. Geol., Compte Rendu, 5th session, pp. 261–267.
Describes the physical and climatic features of the parts of the United States traversed by the Rocky Mountain excursion of the International Congress of Geologists.

212 —— From the Ohio to the Mississippi River. General sketch.
Int. Cong. Geol., Compte Rendu, 5th session, pp. 289–290.
Mentions the different exposures of Silurian, Devonian, and Carboniferous rocks and describes the glacial phenomena of the region traversed by the geological excursion.

213 —— Great Salt Lake and Lake Bonneville. Fault Scarps. Itinerary, Pocatello, Idaho, to Salt Lake City, Utah.
Int. Cong. Geol., Compte Rendu, 5th session, pp. 374–380.
Describes the geologic history of Lake Bonneville, the fault scarps of the mountains of the Great Basin, and the geology along the railroad from Pocatello to Salt Lake City.

214 —— Great Salt Lake Valley, and Itinerary, Salt Lake City to Spanish Fork Canyon [Utah].
Int. Cong. Geol., Compte Rendu, 5th session, pp. 391–397.
Describes the geologic history of Great Salt Lake Valley and the local geology along the railroad to Spanish Fork Canyon.

215 —— Itinerary, Chicago to Niagara Falls.
Int. Cong. Geol., Compte Rendu, 5th session, pp. 453–458.
Describes the local geology between Chicago and Niagara Falls, through Michigan and the Province of Ontario, and the geologic history of Niagara Falls.

216 —— Itinerary, Albuquerque, N. Mex., to Flagstaff, Ariz., and to the Grand Canyon.
Int. Cong. Geol., Compte Rendu, 5th session, pp. 468–474.
Describes the geology along the route traversed by the western excursion of the International Congress of Geologists.

217 —— The name "Newark" in American stratigraphy.
Jour. of Geol., vol. ii, pp. 55–59.
Discusses the principles of stratigraphic nomenclature in reference to the use of the term "Newark" in geologic literature.

218 —— Continental problems of geology.
Smith. Inst., Ann. Rept., 1891–92, pp. 163–173.
Noticed in Bibliography and Index for 1892 and 1893.

218*a* —— The chemical equivalence of crystalline and sedimentary rocks.
Abstract: Am. Geol., vol. xiii, pp. 213–214.

219 **Gorby** (S. S.). [Natural resources of Indiana.]

Ind. Dept. Geol. and Nat. Res., 18th Rept., pp. 9–16.

Reviews the developments in the coal, building stone, clays, gas, and petroleum industries of Indiana in 1893.

220 **Grabau** (Amadeus W.). The pre-Glacial channel of the Genesee River.

Bost. Soc. Nat. Hist., Proc., vol. xxvi, pp. 359–369.

Abstract: Am. Geol., vol. xiv, pp. 397–398 (½ p.).

Describes the modern channel of the river, the topography of the adjacent region, the relations of the Genesee and Wyoming valleys and the Dansville-Rochester Valley, and gives a summary of conclusions.

221 **Grant** (Uly S.). The State of Minnesota.

Int. Cong. Geol., Compte Rendu, 5th session, pp. 302–311.

Describes the topography, the outcrops of Archean and Algonkian, Cambrian, and Silurian formations, and the glacial deposits of the portion of the State crossed by the excursion.

222 —— La Crosse to Minneapolis and Minneapolis to Moorhead. Itinerary.

Int. Cong. Geol., Compte Rendu, 5th session, pp. 312–317.

Describes the local geology along the route traversed by the excursion of the International Congress of Geologists.

223 —— The geology of Kekequabic Lake, in northeastern Minnesota, with special reference to an augite soda-granite.

Minn. Geol. and Nat. Hist. Surv., 21st Ann. Rept., pp. 9–58, pls. i–ii, figs. 1–4.

Describes the topography and reviews the previous literature on the region. Describes the ancient clastic and igneous rocks and the field relations and petrographic characters of the granite.

224 —— Preliminary report of field work during 1893 in northeastern Minnesota.

Minn. Geol. and Nat. Hist. Surv., 22d Ann. Rept., pp. 67–78.

Describes the topography and the lithologic character and structure of the Animike and Keweenawan beds of the region.

225 —— Volcanic rocks in the Keewatin of Minnesota.

Science, vol. xxiii, p. 17.

Describes the petrographic characteristics of some volcanic rocks occurring in Keewatin strata.

226 —— Note on the Keweenawan rocks of Grand Portage Island, north coast of Lake Superior.

Am. Geol., vol. xiii, pp. 437–439.

Describes the sedimentary and igneous rocks of this island and considers that the former belong to the lower part of the Keweenawan.

227 **Gresley** (W. S.). Cone-in-cone: how it occurs in the Devonian series in Pennsylvania, United States of America, with further details of its structure.

Geol. Soc. London, Quart. Jour., vol. l, pp. 731–739, pls. xxxv–xxxvi.

Abstract: Am. Geol., vol, xiv, pp. 399–400 (⅛ p.).

Describes the occurrence of cone-in-cone structure in Devonian beds of Pennsylvania.

228 **Gresley** (W. S.). The "slate binders" of the "Pittsburg" coal bed.

Am. Geol., vol. xiv, pp. 356–365, figs. 1–2.

Describes the character of the slate partings and discusses the different theories which may account for the formation of similar beds.

229 **Grimsley** (G. Perry). The granites of Cecil County, in northeastern Maryland.

Cin. Soc. Nat. Hist., Jour., vol. xvii, pp. 59–67, pls. 4–5, and pp. 78–114.

Abstracts: Jour. of Geol., vol. ii, pp. 865–866; Am. Geol., vol. xiv, p. 398 (½ p).

Describes the rock exposures and the microscopic characters of the granite, diorite, staurolitic mica-schist, and granite-gneiss found in this region. Gives a summary of conclusions.

229*a* **Griswold** (L. S.), **Davis** (W. M.) and. Eastern boundary of the Connecticut Triassic.

Geol Soc. Am., Bull., vol. v, pp. 515–530.

See Davis (W. M.) and Griswold (L. S.), No. 139.

229*b* **Gulliver** (F. P.). Ice sheet on Newtonville sand plain.

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xlii, p. 178 (⅓ p.)

Noticed in Bibliography and Index for 1892 and 1893.

230 **Gurlt** (Adolf). On a remarkable deposit of wolfram ore in the United States.

Am. Inst. Mg. Engrs., Trans., vol. xxii, pp. 236–242.

Describes an occurrence of wolfram ore in Fairfield County, Conn., in crystalline limestone and gneiss.

H.

231 **Hague** (Arnold). The great plains of the North. General sketch. Itinerary from Jamestown, N. Dak., to Livingston, Mont.

Int. Cong. Geol., Compte Rendu, 5th session, pp. 319–325.

Describes the general geologic features of the great plains and the local geology of the route traversed by the Rocky Mountain excursion of the International Congress of Geologists.

232 —— The Yellowstone Park.

Int. Cong. Geol., Compte Rendu, 5th session, pp. 336–359.

Describes the geologic history of the park and the physical and geologic features of the route through the park traversed by the excursion.

232*a* —— Geologic history of the Yellowstone National Park.

Smith. Inst., Ann. Rept., 1891-92, pp. 133–151.

Noticed in Record of North American Geology for 1887–1889.

233 **Hall** (James). The Livonia salt shaft; its history and geological relations, etc.

N. Y. State Mus., 47th Ann. Rept., pp. 205–214.

Gives an account of the geologic work done during the sinking of the Livonia shaft and describes the relations of the formations.

234 **Hall** (James). [Correlation of clastic rocks.]

Int. Cong. Geol., Compte Rendu, 5th session, p. 170 (¼ p.).

Remarks on the importance of considering both physical and faunal characters and the unequal value of fossils in the correlating of rocks.

235 —— and **Clarke** (J. M.). Paleontology of New York, vol. viii, pt. 2.

N. Y. State Mus., 47th Ann. Rept., pp. 797–851.

Includes a synopsis of contents of vol. viii, pt. ii, and a summary of "The evolution of the genera of the Paleozoic Brachiopoda" and description of new species figured in the same volume.

236 —— —— An introduction to the study of the Brachiopoda, intended as a handbook for the use of students. Part II.

N. Y. State Mus., 47th Ann. Rept., pp. 945–1137.

Continues the description of genera began in part i, discusses the evolution and classification of the genera of the Brachiopoda, and gives a table of classification and an alphabetical index to genera and subgenera of the Brachiopoda.

236*a* —— —— An introduction to the study of the genera of Paleozoic Brachiopoda, vol. viii, part ii, fascicle i.

Abstracts: Am. Jour. Sci., 3d ser., vol. xlvii, p. 319 (¼ p.); Am. Jour. Sci., 3d ser., vol. xlviii, pp. 71–72.

Noticed in Bibliography and Index for 1892 and 1893.

237 **Hallock** (William). Note on further observations of temperature in the deep well at Wheeling, W. Va.

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xlii, pp. 173–175.

In tabular form shows the temperature of the water which had leaked into the well to a depth of 3,196 feet.

238 **Halse** (Edward). Notes on some gold-bearing veins of Zacatecas, Mexico.

Eng. and Mg. Jour., vol. lviii, p. 78 and pp. 105–107.

Notes on the vein structure and character of the ore.

239 —— Gold in Zacatecas, Mexico.

Eng. and Mg. Jour., vol. lviii, pp. 605–606.

Brief description of the ore deposits.

240 **Harrington** (B. J.). The composition of limestones and dolomites from a number of geological horizons in Canada.

Can. Rec. Sci., vol. vi, pp. 27–32.

Gives the chemical composition of Cambrian, Silurian, Carboniferous, and Triassic limestones from different localities of Canada.

241 —— On nepheline, sodalite, and orthoclase from the nepheline syenite of Dungannon, Hastings County, Ontario.

Am. Jour. Sci., 3d ser., vol. xlviii, pp. 16–18.

Abstract: Am. Geol., vol. xiv, p. 68 (5 l.).

Describes the chemical composition of the minerals mentioned.

242 **Harris** (Gilbert D.). The Tertiary geology of southern Arkansas.

Ark. Geol. Surv., Ann. Rept., 1892, vol. ii, pp. 1–207, with geologic map, pls. i–vii, and figs. 1–34.

Abstracts: Jour. of Geol., vol. ii, p. 867 (⅛ p.); Am. Geol., vol. xiv, pp. 394–395 (⅛ p.).

Reviews the literature on the Tertiary of this region. Describes the character of the rocks on which the Tertiary beds were deposited, the different stages of the Tertiary epoch and the fossil fauna, and includes the author's summary.

243 —— On the geological position of the Eocene deposits of Maryland and Virginia.

Am. Jour. Sci., 3d ser., vol. xlvii, pp. 391–304, figs. 1–3.

Reviews previous determinations of fossils collected in this region and gives a general section of the Eocene series of the Southern States.

244 **Harris** (Hunter L.). A new instance of stream capture.

Bost. Soc. Nat. Hist., Proc., vol. xxvi, pp. 27–29.

Describes briefly the drainage of Hominy Creek and Pigeon River, in North Carolina.

245 **Harris** (T. W.). The kames of the Oriskany Valley [New York].

Am. Geol., vol. xiii, pp. 384-390.

Describes the drainage systems of central and western New York and the glacial deposits of the Oriskany Valley.

246 **Hastings** (J. B.). Some notes on Idaho mines.

Eng. and Mg. Jour., vol. lvii, pp. 267-268 (correspondence).

Describes placer deposits of Snake River Valley.

247 —— The Boise Basin, in Idaho.

Sci. Am. Suppl., vol. xxxviii, pp. 15540–15541; Eng. and Mg. Jour., vol. lviii, p. 56.

Describes the placer deposits and the character and structure of the quartz veins from which the placer gold was derived.

248 **Hatcher** (J. B.) A median horned rhinoceros from the Loup Fork beds of Nebraska.

Am. Geol., vol. xiii, pp. 149–150.

Names and describes Teleoceras major, a new genus from the Loup Fork beds of Nebraska.

249 —— Discovery of Diceratherium, the two-horned rhinoceros, in the White River beds of South Dakota.

Am. Geol., vol. xiii, pp. 360–361 (correspondence).

Describes the type specimen found in the Oreodon beds (Protoceras beds of Wortman).

250 —— On a small collection of vertebrate fossils from the Loup Fork beds of northwestern Nebraska; with note on the geology of the region.

Am. Nat., vol. xxviii, pp. 236–248, pls. i–ii.

Describes two new species from the Miocene of Nebraska and the lithologic character and structure of the Loup Fork beds in which they are found.

251 **Haworth** (Erasmus). Relative value of limestone, sandstone, and shale for stratigraphic work in Kansas.

Kans. Univ. Quart., vol. ii, pp. 102–104.

States that in Kansas the limestones are more important for stratigraphic purposes than either sandstone or shale, on account of their regularity and persistency in lateral extent.

252 —— A geologic section along the Atchison, Topeka and Santa Fe Railroad, from Cherryvale to Lawrence and from Ottawa to Holliday [Kansas].

Kans. Univ. Quart., vol. ii, pp. 118–126.

Describes the strata along the line of this section and correlates certain beds with those of other sections previously described.

253 —— Résumé of stratigraphy of eastern Kansas.

Kans. Univ. Quart., vol. ii, pp. 126–129.

Gives a general sketch of the succession of the formations in eastern Kansas as shown by the several sections previously described.

254 —— The topography of eastern Kansas.

Kans. Univ. Quart., vol. ii, pp. 129–136.

Describes the general topographic features of eastern Kansas.

255 —— The surface gravels of eastern Kansas.

Kans. Univ. Quart., vol. ii, pp. 136–142.

Describes the distribution of the gravels, and considers that they are residual products derived from the weathering of the underlying formations.

256 —— and **Kirk** (M. Z.). A geologic section along the Neosho River from the Mississippian formation of the Indian Territory to White City, Kans., and along the Cottonwood River from Wyckoff to Peabody.

Kans. Univ. Quart., vol. ii, pp. 104–115.

Describes the limestones, sandstones, and shales outcropping along the Neosho and Cottonwood rivers.

257 —— and **Piatt** (W. H. H.). A geologic section along the Verdigris River from the State line to Madison [Kans.]

Kans. Univ. Quart., vol. ii, pp. 115–118.

Describes the stratigraphy along the Verdigris River.

258 **Hayes** (C. Willard). Geology of a portion of the Coosa Valley, in Georgia and Alabama.

Geol. Soc. Am., Bull., vol. v, pp. 465–480, pl. 18.

Abstract: Am. Geol., vol. xiii, p. 142 (8 l.).

Describes the physical features of the region and the succession of the Cambrian, Silurian, and Devonian rocks. Discusses the structure and gives a sketch of its Paleozoic and post-Paleozoic history.

259 —— On the Devonian (Oriskany) in the southern Appalachians.

Am. Jour. Sci., 3d ser., vol. xlvii, pp. 237–238 (communicated).

Mentions fossils of Devonian facies found in a ferruginous sandstone in Alabama which rests on Trenton or Hudson River strata. Considers the unconformity between the beds to be due to overlap of deposition and not to faulting.

260 **Hayes** (C. Willard). Ringgold folio. Georgia, Tennessee.

U. S. Geol. Surv., Geologic Atlas of the United States, folio 2.

Describes the geography and the occurrence and character of the Cambrian, Silurian, Devonian, and Carboniferous strata and the mineral resources, including coal, iron, and the soils, of the region. Inclndes topographic, colored areal geologic, economic geologic, and structure section maps and a sheet of columnar sections.

261 —— Kingston folio. Tennessee.

U. S. Geol. Surv., Geologic Atlas of the United States, folio 4.

Describes the geography and drainage, the occurrence and lithologic character of the Cambrian, Silurian, Devonian, and Carboniferous strata, the geologic structure and the occurrence of coal, iron ores, and soils of the region. Includes topographic, colored areal geologic, economic geologic, and structure section maps and a sheet of columnar sections.

262 —— Chattanooga folio. Tennessee.

U. S. Geol. Surv., Geologic Atlas of the United States, folio 6.

Describes the physiography, the occurrence and distribution of the Cambrian, Silurian, Devonian, and Carboniferous strata, the geologic structure, and the coal and iron deposits and soils of the region. Includes topographic, colored areal geologic, economic geologic, and structure section maps and a sheet of columnar sections.

263 —— Sewanee folio. Tennessee.

U. S. Geol. Surv., Geologic Atlas of the United States, folio 8.

Describes the physiography and drainage of the region, the occurrence and distribution of the Silurian, Devonian, and Carboniferous strata, the geologic structure and the mineral resources, including coal and iron. Contains topographic, colored areal geologic, economic geologic, and structure section maps and a sheet of columnar sections.

264 —— and **Campbell** (M. R.). Geomorphology of the southern Appalachians.

Nat. Geog. Mag., vol. vi, pp. 63–126, pls. 4–6.

Reviews the previous work in the region. Describes the several types of the deformed Cretaceous peneplain, the deformation of the Cretaceous and Tertiary peneplains, and the drainage development as affected by dynamic movements. Includes a discussion of the sedimentary record.

265 **Herrick** (C. L.). Observations upon the so-called Waverly group of Ohio.

Ohio Geol. Surv., vol. vii, pp. 495–515.

Describes the character and distribution of the Waverly strata and gives list of fossils from different localities.

266 **Hershey** (Oscar H.). The Elk Horn Creek area of St. Peter sandstone, in northwestern Illinois.

Am. Geol., vol. xiv, pp. 169–179, with map.

Describes the lithologic character of the Lower Magnesian limestone, the St. Peter sandstone, and the Trenton limestone in the area and the deformation they have undergone. Gives a general summary of the geologic features of the region.

266*a* **Hershey** (Oscar H.). The Pleistocene rock gorges of northwestern Illinois.

Abstract: Jour. of Geol., vol. ii, pp. 240–241.
Noticed in Bibliography and Index for 1892 and 1893.

267 **Hilgard** (E. W.). [Correlation of clastic rocks.]

Int. Cong. Geol., Compte Rendu, 5th session, p. 167 (7 l).
Remarks on the consideration of the abundance and scarcity of species in the correlation of strata.

268 **Hill** (B. H.). Notes on Uintacrinus socialis Grinnell.

Kans. Univ. Quart., vol. ii, pp. 20–21.
Gives a diagram and brief description of the crinoid.

269 **Hill** (E. J.). An early observation on the history of the Great Lakes.

Am. Geol., vol. xiv, p. 405 (½ p.) (correspondence).
Gives an extract from a report of Alexander Henry in 1761, published in 1809.

270 **Hill** (Robert T.). Notes on the Tertiary and later history of the Island of Cuba.

Am. Jour. Sci., 3d ser., vol. xlviii, pp. 196–212.
Describes the metamorphic and igneous rocks, the pre-Tertiary sedimentaries, the Tertiary limestones, the post-Tertiary folding, the terraces and elevated coral reefs, and the cienagas. Discusses the different phases of the geologic history of the island as indicated by its topography.

271 —— Geology of parts of Texas, Indian Territory, and Arkansas adjacent to Red River.

Geol. Soc. Am., Bull., vol. v, pp. 297–338, pls. 12–13.
Abstracts: Am. Jour. Sci., 3d ser., vol. xlvii, p. 141 (⅔ p.); Am. Geol., vol. xiii, pp. 208–209 (½ p.).
Describes the physiography of the region. Gives a list of the Cretaceous, Tertiary, and Pleistocene formations and their subdivisions, whose outcrops at different localities are described. Gives lists of fossils found at certain horizons, discusses the oscillations of land and sea, and includes the author's conclusions as to the Cretaceous section of the region. Plate 12 contains a geologic map and cross sections.

272 **Hillebrand** (W. F.). [Beaver Creek meteorite.]

Am. Jour. Sci., 3d. ser., vol. xlvii, pp. 431–435.
Discusses the chemical composition of this meteorite.

273 **Hind** (Wheelton). [On the occurrence of the genus Naiadites in the coal formation of Nova Scotia.]

Geol. Soc. London, Quart. Jour., vol. l, pp. 437–442.
Gives a list of synonyms of Naiadites and describes the character of the genus.

274 **Hinde** (George Jennings). Note on the radiolarian chert from Angel Island and from Buri-Buri Ridge, San Mateo County, Cal.

Univ. of Cal., Dept. of Geol., Bull., vol. i, pp. 235–240.
Describes the occurrence of Radiolaria in cherts and the details of those forms which can be partially identified.

275 **Hinde** (George Jennings). [Origin of the novaculites of Arkansas.]

Geol. Soc. London, Quart. Jour., vol. l, pp. 391–392.

In discussion of paper by F. Rutley on the "Origin of certain novaculites and quartzites."

276 **Hitchcock** (C. H.). Glaciation of the White Mountains, New Hampshire.

Geol. Soc. Am., Bull., vol. v, pp. 35–37.

Discusses the evidences which indicate that glaciation has extended over the highest of the White Mountains.

276*a* —— Ancient eruptive rocks in the White Mountains.

Abstract: Am. Geol., vol. xiii, p. 213 (¾ p.).

277 **Hobbs** (William H.). Volcanite, an anorthoclase-augite rock chemically like the dacite.

Abstracts: Geol. Soc. Am., Bull., vol. v, pp. 598–602; Am. Geol., vol. xiii, p. 214 (7 l.).

Describes the petrographic character and chemical composition of a volcanic rock from the Lipari Islands.

278 —— On a recent diamond find in Wisconsin and of the probable origin of this and other Wisconsin diamonds.

Am. Geol., vol. xiv, pp. 31–35, with map.

Describes the location and occurrence of the diamonds that have been found in Wisconsin.

279 —— Differential faults.

Am. Geol., vol. xiv, pp. 35–37.

Describes a strike fault occurring in the Green Mountains of Massachusetts and Connecticut.

279*a* —— Geological structure of the Hoosatonic Valley, lying east of Mount Washington, Massachusetts.

Abstract: Am. Geol., vol. xiii, p. 142 (½ p.).

Noticed in Bibliography and Index for 1892 and 1893.

279*b* —— The geologic structure of the Mount Washington mass of the Taconic range.

Abstract: Am. Nat., vol. xxviii, pp. 158–160.

Noticed in Bibliography and Index for 1892 and 1893.

280 **Hollick** (Arthur). Additions to the paleobotany of the Cretaceous formation of Long Island [New York].

Torrey Bot. Club, Bull., vol. xxi, pp. 49–65, pls. 174–180.

Abstract: Am. Jour. Sci., 3d ser., vol. xlvii, p. 402.

Describes eight new species from this horizon.

281 —— Fossil salvinias, including description of a new species.

Torrey Bot. Club, Bull., vol. xxi, pp. 253–257, pl. 205.

Refers to the literature of this genus and describes Salvinia elliptica Newb. from the Upper Cretaceous of Washington.

282 —— A new fossil nelumbo from the Laramie group at Florence, Colo.

Torrey Bot. Club, Bull., vol. xxi, pp. 307–310.

Describes and figures a leaf of Nelumbo laramiensis n. sp.

283 **Hollick** (Arthur). Observations on the geology and botany of Marthas Vineyard [Mass.].

N. Y. Acad. Sci., vol. xiii, pp. 8–22.

Abstract: Am. Nat., vol. xxviii, pp. 265–266 (⅛ p.).

Reviews the previous descriptions of the geology of Marthas Vineyard.

284 —— [On previous descriptions of Spiraxis major and Spiraxis randalli from the Chemung sandstones.]

N. Y. Acad. Sci., Trans., vol. xiii, pp. 118–119.

Refers to descriptions of these species by Dr. Newberry and compares them with Cladoselache newberryi.

285 —— Some further notes on the geology of the north shore of Long Island [NewYork].

N. Y. Acad. Sci., Trans., vol. xiii, pp. 122–130.

Abstract: Am. Jour. Sci., 3d ser., vol. xlvii, p. 402.

Discusses the evidences which indicate the presence of Cretaceous strata and the distribution of the glacial deposits in this region.

285*a* —— Recent investigations in the Cretaceous formation on Long Island, New York.

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xlii, p. 175 (½ p.).

286 —— Notes on the northward extension of the Yellow Gravel in New Jersey, Staten Island, Long Island, and eastward.

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xlii, pp. 175–176.

Brief note on the distribution of the Yellow Gravel.

287 **Holmes** (J. A.) Geology of the sand-hill country of the Carolinas.

Abstract: Geol. Soc. Am., Bull., vol. v, pp. 33–34.

Describes the section between the Neuse and Savannah rivers and the general features of the Cretaceous and Tertiary deposits.

288 **Holst** (Nils Olaf). [Classification of Pleistocene deposits.]

Int. Cong. Geol., Compte Rendu, 5th session, pp. 197–198.

Remarks on the unity of the Glacial period.

289 **Hopkins** (T. C.). Springs: the influence of stratigraphy on their emergence, as illustrated in the Ozark uplift.

Am. Geol., vol. xiv, pp. 365–368, with map.

Gives a general section of Paleozoic strata of northern Arkansas and describes the characters of the beds and the distribution of the springs.

289*a* —— Marbles and other limestones.

Reviews: Jour. of Geol., vol. ii, pp. 339–341, by R. A. F. Penrose, jr.; Am. Nat., vol. xxviii, p. 337 (⅛ p.).

Noticed in Bibliography and Index for 1892 and 1893.

289*b* —— **Simonds** (F. W.) and. The geology of Benton County, Ark.

Ark. Geol. Surv., Ann. Rept., 1891, vol. ii, pp. 1–75.

See Simonds (F. W.) and Hopkins (T. C.), No. 511.

290 **Hovey** (E. O.). Microscopic structure of siliceous oolite.

Geol. Soc. Am., Bull., vol. v, pp. 627–629, pl. 21.

Abstract: Am. Geol., vol. xiii, pp. 223–224 (½ p.).

Describes the microscopic structure of siliceous oolite from Pennsylvania and New Jersey.

291 **Hovey** (E. O.). A study of the cherts of Missouri.

Am. Jour. Sci., 3d ser., vol. xlviii, pp. 401–409.

Abstracts: Jour. of Geol., vol. ii, p. 756 (½ p.); Am. Geol., vol. xiv, p. 196 (½ p.).

Describes the petrographic and chemical characteristics of the cherts and discusses their origin.

292 —— Note on the petrography of certain basaltic bowlders from Thetford, Vt.

N. Y. Acad. Sci., Trans., vol. xiii, pp. 161–164.

Gives a chemical analysis of the material and describes the petrographic characters.

292*a* **Howe** (W. T. H.), **Penfield** (S. L.) and. On the chemical composition of chondrodite, humite, and clinohumite.

Am. Jour. Sci., 3d ser., vol. xlvii, pp. 188–206.

See Penfield (S. L.) and Howe (W. T. H.), No. 417.

293 **Howell** (Edwin E.). Beaver Creek meteorite.

Am. Jour. Sci., 3d ser., vol. xlvii, pp. 430–435.

Describes the locality and finding of this meteorite and includes a discussion of its chemical composition by W. F. Hillebrand and of its microscopic characters by G. P. Merrill.

294 **Howorth** (Henry). [Mammoth remains of Canada and Alaska.]

Geol. Soc. London, Quart. Jour., vol. l, pp. 8–9.

In discussion of paper by G. M. Dawson on "Notes on the occurrence of mammoth remains in the Yukon district of Canada and Alaska."

295 **Hubbard** (Lucius L.). Macroscopic minerals of Michigan.

Michigan, Rept. of the State Board of Geol. Surv. for 1891 and 1892, pp. 174–176.

Gives a list of macroscopic minerals found in Michigan.

296 **Hughes** (T. McKenny). [Correlation of clastic rocks.]

Int. Cong. Geol., Compte Rendu, 5th session, p. 59 (¼ p.).

Remarks on the complexity of the data to be considered in the correlation of rocks.

297 —— [Classification of Pleistocene deposits.]

Int. Cong. Geol., Compte Rendu, 5th session, pp. 194–195.

Remarks on the possibility of chronologic and genetic classifications.

298 —— Note on Walnut Canyon and its cliff dwellings.

Int. Cong. Geol., Compte Rendu, 5th session, pp. 475–476.

Describes the Carboniferous section exposed in this canyon.

299 **Hull** (Edward). [Mammoth remains of Canada and Alaska.]

Geol. Soc. London, Quart. Jour., vol. l, p. 9 (¼ p.).

In discussion of paper by G. M. Dawson, "Notes on the occurrence of mammoth remains in the Yukon district of Canada and Alaska."

300 —— [Origin of the novaculites of Arkansas.]

Geol. Soc. London, Quart. Jour., vol. l, p. 392 (½ p.).

In discussion of paper by F. Rutley on the "Origin of certain novaculites and quartzites."

301 **Huntington** (Oliver Whipple). Further observations upon the occurrence of diamonds in meteorites.

Am. Acad. Arts Sci., Proc., vol. xxix, pp. 204–211.

Abstract: Am. Geol., vol. xiii, pp. 284–285 (⅓ p.).

Gives an account of the experiments employed in determining the presence of diamonds in the Canyon Diablo meteorite.

302 —— The Smithville meteoric iron.

Am. Acad. Arts Sci., Proc., vol. xxix, pp. 251–260, figs. 1–2.

Gives a chemical analysis of the material and an account of the finding of other meteoric iron masses in this portion of Tennessee, and the evidences indicating that they possess common characteristics and may have formed originally a part of the same mass.

302*a* —— **Kunz** (George F.) and. The diamond in the Canyon Diablo meteoric iron.

Abstract: Eng. and Mg. Jour., vol. lvii, p. 394.

Noticed in Bibliography and Index for 1892 and 1893.

303 **Hurlburt** (E. B.). On alunite from Red Mountain, Ouray County, Colo.

Am. Jour. Sci., 3d ser., vol. xlviii, pp. 130–131.

Describes the chemical and crystallographic characters of alunite from Colorado.

304 **Hyatt** (Alpheus). Trias and Jura in the Western States.

Geol. Soc. Am., Bull., vol. v, pp. 395–434.

Abstracts: Am. Jour. Sci., 3d ser., vol. xlvii, pp. 142–143; Am. Geol., vol. xiii, p. 148 (⅔ p.).

Discusses the age and faunal relations of the American and Sailors canyons deposits, California, and describes the fauna of the Upper Jura of California. Discusses the relative age of the rocks and describes the characters of fossils from different localities.

305 —— Phylogeny of an acquired characteristic.

Am. Phil. Soc., Proc., vol. xxxii, pp. 349-640, pls. 1–14.

Describes the evidences which show that the tendency of shells toward becoming arcuate and coiled is general in the descendants of straight shells and not confined to any special series or time. Describes genera and species of Nautiloidea.

I.

305*a* **Iddings** (Joseph P.). The eruptive rocks of Electric Peak and Sepulchre Mountain, Yellowstone National Park.

Abstract: Am. Geol., vol. xiv, pp. 117–118.

Noticed in Bibliography and Index for 1892 and 1893.

305*b* —— Genetic relationships among igneous rocks.

Abstracts: Am. Nat., vol. xxviii, p. 515 (½ p.); Am. Geol., vol. xiii, p. 195 (10 l).

Noticed in Bibliography and Index for 1892 and 1893.

305*c* —— A dissected volcano.

Abstract: Am. Nat., vol. xxviii, p. 603 (⅓ p.).

Noticed in Bibliography and Index for 1892 and 1893.

306 **Iddings** (Joseph P.). Petrographical character of the lavas.
U. S. Geol. Surv., 14th Ann. Rept., pt. 2, pp. 520–524.
Describes the petrographic character of the basaltic rocks collected by C. D. Walcott in the Grand Canyon of the Colorado.

307 —— and **Weed** (Walter H.). Livingston Folio. Montana.
U. S. Geol. Surv., Geologic Atlas of the United States, folio 1.
Abstract: Am. Jour. Sci., 3d ser., vol. xlviii, pp. 170-172.
Describes the geography and topography, the geologic relations of the mountain ranges, the character and occurrence of the Algonkian, Cambrian, Devonian, Carboniferous, Juratrias, Cretaceous, Tertiary, and Pleistocene strata and of the igneous rocks, and the occurrence of gold and coal. Includes topographic, colored areal geologic, economic geologic, and structure section maps, and a sheet of columnar sections.

307*a* —— Yellowstone Valley from Livingston to Cinnabar.
Int. Cong. Geol., Compte Rendu, 5th Session, pp. 326–335.
See Weed (W. H.) and Iddings (J. P.), No. 615.

307*b* **Indiana, Department of Geology and Natural Resources.** Eighteenth Annual Report, 1893.
Abstract: Am. Geol., vol. xiv, pp. 125–126.

308 **Ingall** (Elfric Drew). Preliminary note on the limestones of the Laurentian system.
Can. Rec. Sci., vol. vi, pp. 88–91.
Describes the inclusions of gneisses and similar rocks in these limestones, and considers that they represent areas of gneiss altered into limestone in place and that their location has been determined by the bends and contortions of these rocks.

309 **Ingersoll** (Charles A.). On hemimorphic wulfenite crystals from New Mexico.
Am. Jour. Sci., 3d ser., vol. xlviii, pp. 193–195.
Describes the crystallographic characters of the crystals.

310 **Ingram** (Henry B.). The great bluestone industry.
Pop. Sci. Monthly, vol. xlv, pp. 352–359.
Abstract: Jour. of Geol., vol. ii, p. 647 (½ p.).
Describes the occurrence and character of flagstones in New York of Devonian age.

J.

311 **James** (Joseph F.). On the value of supposed algæ as geological guides.
Am. Geol., vol. xiii, pp. 95–101.
Abstract: Am. Assoc. Adv. Sci., Proc., vol. xlii, pp. 172–173 (⅛ p.).
Quotes from different authors as to the geologic occurrence and range of algæ and their value as evidence in determining geologic horizons.

312 **James** (Joseph F.). Manual of the paleontology of the Cincinnati group.

Cin. Soc. Nat. Hist., Jour., vol. xvi, pp. 178–208.

Continues the description of fossils found in the Cincinnati group, from vol. xv, p. 159.

313 —— The St. Peters sandstone.

Cin. Soc. Nat. Hist., Jour., vol. xvii, pp. 115–135.

Gives a historical sketch of the earlier description of the St. Peters sandstone. Describes its distribution and lithologic character and mentions some of the fossils found in it.

313*a* —— Remarks on the genus Arthrophycus Hall.

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xlii, p. 172 (⅔ p.).

313*b* —— Studies in problematic organisms: the genus Fucoides.

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xlii, p. 173 (9 l.).

314 **Jardin** (Ed.). Formation du tuf calcaire ou travertin et des dépots siliceux par la végetation des sources d'eau chaude.

Soc. Acad. de Brest, 2d ser., vol. xix, pp. 33–75.

Reviews the paper by W. H. Weed on the travertine deposits of the Yellowstone National Park and mentions the occurrence of deposits by hot spring waters in Virginia, Arkansas, and California.

315 **Jenney** (Walter P.). The lead and zinc deposits of the Mississippi Valley.

Am. Inst. Mg. Engrs., Trans., vol. xxii, pp. 171–225 and 642–646.

Describes the topography of the lead and zinc mining regions of the Mississippi Valley, the secular upheavals and depressions, their influence on the formation of the ore deposits and the geologic occurrence of the ore bodies in Missouri and Wisconsin, and discusses the theories as to their manner of formation and deposition.

316 **Jennings** (E. P.). The Mesabi iron range.

Science, vol. xxiii, p. 73.

Describes the character and structure of the ore bodies in this region.

317 **Joggar** (T. A., jr.). Some conditions of ripple marks.

Am. Geol., vol. xiii, pp. 199–201 (correspondence).

Reviews paper by J. E. Spurr on "False bedding in stratified drift deposits."

318 **Jones** (Arthur J.). Coal Measures of Powsheik County [Iowa].

Iowa Acad. Sci., Proc., vol. i, pt. iv, pp. 59–60.

Brief note on the occurrence of Coal Measures in this county.

319 —— Cardiocarpus in Iowa.

Iowa Acad. Sci., Proc., vol. i, pt. iv, p. 61.

Note on the occurrence of seeds of this genus found in a seam of bituminous coal.

320 **Jordan** (E. T. J.). Natural gas.

Ind. Dept. Geol. and Nat. Res., 18th Rept., pp. 198–218.

Discusses the evidences as to the loss of pressure in the gas wells of Indiana and the origin of natural gas.

K.

321 **Keith** (Arthur). Harpers Ferry folio. Maryland, Virginia, and West Virginia.

U. S. Geol. Surv., Geologic Atlas of the United States, folio 10.

Describes the geography and drainage of the region, the occurrence of quartz-porphyry, andesite, Catoctin schist, and diabase, the occurrence and distribution of the Cambrian, Juratrias, and Tertiary strata, the geologic structure and the deposits of iron, copper, and building stones. Includes topographic, colored areal geologic, economic geologic, and structure section maps.

322 —— Geology of the Catoctin belt.

U. S. Geol. Surv., 14th Ann. Rept., pt. 2, pp. 285–395, pls. xix–xxxix, fig. 43.

Describes the physical features and reviews the literature of this region—the eastern mountain belt of Maryland and Virginia. Describes the occurrence and composition of the granite, quartz-porphyry, andesite, and Catoctin schist, and discusses the relations of these igneous and volcanic rocks. Describes the occurrence and lithologic composition of the sedimentary beds of Cambrian, Silurian, and Juratrias age. Discusses the geologic structure and the geomorphology of the region.

323 **Kemp** (James Furman). Preliminary report on the geology of Essex County [N. Y.].

N. Y. State Mus., 47th Ann. Rept., pp. 627–666.

Gives a list of 38 papers on the geology and mineralogy of the Adirondacks. Discusses the general geologic relations and reviews the schemes of classification of rocks of this region previously published. Describes the geology of the different townships of the county, illustrated by maps showing the distribution of the crystalline and sedimentary formations.

324 —— [Relation of deformation to ore deposition.]

Geol. Soc. Am., Bull., vol. v, p. 32 (⅓ p.).

In discussion of paper by W. P. Blake on the "Wisconsin lead and zinc deposits."

325 —— Gabbros on the western shore of Lake Champlain [N. Y.].

Geol. Soc. Am., Bull., vol. v, pp. 213–224.

Abstracts: Am. Geol., vol. xiii, pp. 214–215 (½ p.); Am. Nat., vol. xxviii, pp. 947–948.

Reviews the previous descriptions of the geology of the Adirondacks; describes the distribution of the gabbros, the composition of the anorthosytes, the occurrence and petrographic character of the basic gabbros, the titaniferous magnetite ore bodies and the contacts of gabbro and limestone.

326 —— The ore deposits at Franklin Furnace and Ogdensburg, N. J.

N. Y. Acad. Sci., Trans., vol. xiii, pp. 76–96.

Abstract: Am. Geol., vol. xiv, p. 202 (¼ p.).

Describes the minerals and ore bodies of these localities; describes the general geologic relations, the character, and the structure of the ore bodies and discusses the origin of the ore. Gives a list of all minerals and a list of 32 papers on minerals and ores found at these localities.

327 **Kemp** (James Furman). An orbicular granite from Quonochontogue Beach, Rhode Island.

N. Y. Acad. Sci., Trans., vol. xiii, pp. 140–144, pl. ii.

Abstract: Am. Geol., vol. xiv, p. 53 (⅓ p.).

Describes the occurrence of granite bowlders and their petrographic character.

328 —— Additional note on leucite, in Sussex County, N. J.

Am. Jour. Sci., 3d ser., vol. xlvii, pp. 339–340.

Abstract: Am. Nat., vol. xxviii, p. 873 (6 l.).

Describes the occurrence of leucite in a dike rock of this locality.

328*a* —— and **Hollick** (A.). The granite at Mounts Adam and Eve, Warwick, Orange County, N. Y.

Abstract: Am. Geol., vol. xiii, p. 427 (⅛ p.).

Noticed in Bibliography and Index for 1892 and 1893.

328*b* —— and **Marsters** (V. F.). The trap dikes of the Lake Champlain region.

Abstract: Am. Geol., vol. xiii, pp. 426–427 (⅜ p.).

Noticed in Bibliography and Index for 1892 and 1893.

329 **Kennedy** (W.) Geology of Jefferson County, Tex.

Am. Geol., vol. xiii, pp. 268–275.

Gives the section displayed by a well boring to a depth of 400 feet. The greater portion of the county is considered to be of very recent origin.

330 —— The age of the iron ores of east Texas.

Science, vol. xxiii, pp. 22–25.

Reviews the work previously done in this region. Describes the character of the ore bodies and discusses the evidence bearing on their geologic age.

331 **Keyes** (Charles Rollin). Crustal adjustment in the Upper Mississippi Valley.

Geol. Soc. Am., Bull., vol. v, pp. 231–242.

Abstract: Am. Geol., vol. xiii, pp. 210–211 (⅛ p.).

Describes the structure and character of the deformations of the Carboniferous basin of the Mississippi Valley and the character of the folds and faults of the region. Includes the author's summary of conclusions.

332 —— The nature of coal horizons.

Jour. of Geol., vol. ii, pp. 178–186.

Describes the character of a coal horizon at time of formation, the stratigraphy of coal beds, and a coal horizon as it now exists.

333 —— Origin of anthracite.

Am. Geol., vol. xiii, p. 411–415.

Reviews a paper by J. J. Stevenson on the origin of anthracite and describes some of the physical changes which vegetable material undergoes in the formation of coal.

333*a* **Keyes** (Charles Rollin). Coal deposits of Iowa.

Iowa Geol. Surv., vol. ii, p. 536, pls. i–xviii, figs. 1–222.

Discusses the origin of coal. Describes the geologic features of the Carboniferous basin of the Mississippi Valley, the geology of the coal area, the lithologic and stratigraphic characteristics of the Coal Measures, and the local features of the coal beds of the various counties of the State.

334 —— Cretaceous formations of northwestern Iowa.

Abstract: Iowa Acad. Sci., Proc., vol. i, pt. iv, pp. 24–25.

Mentions the subdivisions of the Cretaceous found in this part of Iowa.

335 —— Derivation of the Unione fauna of the Northwest.

Iowa Acad. Sci., Proc., vol. i, pt. iv, pp. 25–29.

Describes the geographic and geologic distribution of Unionidæ in North America.

336 —— Process of formation of certain quartzites.

Abstract: Iowa Acad. Sci., Proc., vol. i, pt. iv, pp. 29–31.

Describes the formation of the Sioux quartzite of Iowa.

336*a* —— The Coal Measures of Iowa.

Abstracts: Eng. and Mg. Jour., vol. lvii, pp. 269–270, 295–297, and 317–318; Am. Geol., vol. xiii, pp. 353–354.

Noticed in Bibliography and Index for 1892 and 1893.

336*b* —— Some Maryland granites and their origin.

Review: Am. Geol., vol. xiii, p. 63 (½ p.).

Noticed in Bibliography and Index for 1892 and 1893.

336*c* —— Epidote as a primary constituent of eruptive rocks.

Review: Am. Geol., vol. xiii, p. 63 (¼ p.).

Noticed in Biliography and Index for 1892 and 1893.

336*d* **Kindle** (E. M.), **Marsters** (V. F.) and. Geologic literature of Indiana (stratigraphic and economic).

Ind. Acad. Sci., Proc., 1893, pp. 156–191.

See Marsters (V. F.) and Kindle (E. M.), No. 402.

336*e* **King** (Clarence). The age of the earth.

Smith. Inst., Ann. Rept., 1892–93, pp. 335–352.

Noticed in Bibliography and Index for 1892 and 1893.

337 **King** (Francis P.). A preliminary report on the corundum deposits of Georgia.

Ga. Geol. Surv., Bull. No. 2, pp. 133, with geologic map of north Georgia.

Gives a historical sketch of corundum and a description of its physical features, alterations, and associate minerals. Describes its geographic and geologic distribution in Georgia, and gives a list of 33 American papers on corundum.

338 —— Natural and artificial abrasives.

Ga. Geol. Surv., Bull. No. 2, pp. 119–133.

Describes the character and occurrence of pumice, infusorial earth, tripoli, buhrstone, grindstones, oilstones, and whetstones.

339 **Kingsley** (J. S.). The classification of the Arthropoda.

Am. Nat., vol. xxviii, pp. 118–135 and 220–235.

Reviews the previous classifications of Arthropoda, presents the author's scheme of classification, with a description of the characters of different groups, and includes a bibliography of the literature cited, consisting of 81 papers.

339*a* **Kirk** (M. Z.), **Haworth** (E.) and. A geologic section along the Neosho River from the Mississippian formation of the Indian Territory to White City, Kans., and along the Cottonwood River from Wyckoff to Peabody.

Kans. Univ. Quart., vol. ii, pp. 104–115.

See Haworth (E.) and Kirk (M. Z.), No. 256.

340 **Knowlton** (F. H.). Fossil flora of Alaska.

Geol. Soc. Am., Bull., vol. v, pp. 573–590.

Abstracts: Am. Jour. Sci., 3d ser., vol. xlvii, p. 137 (⅓ p.); Am. Geol., vol. xiii, p. 137 (4 l.).

Gives a historical review of the literature of the subject and a list of fossil plants heretofore collected in Alaska, and discusses the geologic age of the beds as shown by the fossil flora.

341 —— Fossil wood from the Black Hills, South Dakota.

Jour. of Geol., vol. ii, pp. 260–261.

Describes the structure of the wood of genus Araucarioxylon.

342 —— Fossil plants as an aid to geology.

Jour. of Geol., vol. ii, pp. 365–382.

Abstract: Am. Geol., vol. xiv, p. 335 (¾ p.).

Discusses some of the principles of paleobotany, the use of fossil plants in restricted areas, the study of fossil plants by means of internal structure, and the subsidiary use of fossil plants.

343 —— Note on a few fossil plants from the Fort Union group of Montana, with a description of one new species.

U. S. Nat. Mus., Proc., vol. xvi, pp. 33–36, pls. i–ii.

Describes and figures Populus meedsii n. sp. and Pterospermites cupanioides Newby. sp.

344 —— A new fossil hepatic from the Lower Yellowstone in Montana.

Torrey Bot. Club., Bull., vol. xxi, pp. 458–460, pl. 219.

Describes and figures Precissites wardii n. gen. et sp.

344*a* **Kreider** (D. A.), **Penfield** (S. L.) and. Mineralogical notes.

Am. Jour. Sci., 3d ser., vol. xlviii, pp. 141–144.

See Penfield (S. L.) and Kreider (D. A.), No. 448.

334*b* **Kummel** (H. B.), **Salisbury** (R. D.) and. Surface geology. Lake Passaic, an extinct glacial lake.

N. J. Geol. Surv., Rept. for 1893, pp. 225–328.

See Salisbury (R. D.) and Kummel (H. B.), No. 492.

345 **Kunz** (George F.). Topaz from Texas.

Am. Jour. Sci., 3d ser., vol. xlvii, pp. 403–404 (communicated).

Gives the crystallographic measurements of topaz, and remarks on the characters of a diamond from Wisconsin.

346 **Kunz** (George F.). A new locality of true emeralds.

Am. Jour. Sci., 3d ser., vol. xlviii, pp. 429–430.

Describes the occurrence and physical character of emeralds found in North Carolina.

347 —— Mineralogical notes.

N. Y. Acad. Sci., Trans., vol. xiii, pp. 144–145.

Notes on topaz from Texas and diamonds from Wisconsin.

347*a* —— and **Huntington** (O. W.). The diamond in the Canyon Diablo meteoric iron.

Abstract: Eng. and Mg. Jour., vol. lvii, p. 394.

Noticed in Bibliography and Index for 1892 and 1893.

L.

348 **Lakes** (Arthur). Colorado's new gold camps.

Eng. Mag., vol. vii, pp. 623–638.

Describes the occurrence of gold ores at Cripple Creek, the silver ores of Creede, and the newly discovered gold belt at Leadville.

349 **Lane** (Alfred C.). Geologic activity of the earth's originally absorbed gases.

Geol. Soc. Am., Bull., vol. v, pp. 259–280.

Abstract: Am. Geol., vol. xiii, pp. 138–139.

Describes the nature of the absorbed gases and their importance in the crystallization of plutonic rocks. Discusses the possibility of deep-seated cracking, igneous phenomena and their causes, and the characteristics of contact and magmatic zones.

350 —— Microscopic characters of rocks and minerals of Michigan.

Michigan, Rept. of State Board of Geol. Surv. for 1891–92, pp. 176–183.

Describes the occurrence of quartz-diabase, amphibolite and hornblende schists and lamprophyres.

351 —— What is Archean?

Science, vol. xxiii, p. 128.

Discusses the use of the terms Azoic and Archean.

352 **Lawson** (Andrew C.). The geology of Carmelo Bay.

Univ. of Cal., Dept. of Geol., Bull., vol. i, pp. 1–59, pls. 1–4.

Abstract: Am. Nat., vol. xxviii, pp. 57–58.

Describes the general physiography and geology of the region, the petrographic characters of the Santa Lucia granite of the Carmelo and Monterey series and of the eruptive rocks. Discusses the evidences of the ancient baselevels of the Pacific Coast. In this work Professor Lawson was assisted by Mr. Juan de la C. Posada.

353 —— The Post-Pliocene diastrophism of the coast of southern California.

Univ. of Cal., Dept. of Geol., Bull., vol. i, pp. 115–160, pls. 8–9.

Reviews: Jour. of Geol., vol. ii, pp. 235–238, by R. D. Salisbury; Am. Geol., vol. xiv, pp. 335–338; Am. Nat., vol. xxviii, pp. 340–341 (½ p.).

Discusses the evidences which indicate an uplift of 800 to 1,500 feet along the coast of southern California during post-Pliocene time, and of a differential movement of the crust in the same region.

354 **Lawson** (Andrew C.). The geomorphology of the coast of northern California.

Univ. of Cal., Dept. of Geol., Bull., vol. i, pp, 241–272.

Discusses the evidences of a general uplift along the northern California coast line in Pliocene time and of the more recent subsidence of the Golden Gate.

355 —— A multiple diabase dike.

Am. Geol., vol. xiii, pp. 293–297, pl. vii.

Describes a diabase dike occurring on an island near the northeast coast of Lake Superior, in which the dike is split up into 28 vertically intrusive sheets in a breadth of 14 feet. These sheets represent but one invasion of the magma, and the granite which they penetrate is apparently homogeneous.

356 —— Note on the Chehalis sandstone.

Am. Geol., vol. xiii, pp. 436–437 (correspondence).

Describes the occurrence of this sandstone in Washington, mentions the fossils found in it, which indicate that it belongs to the Eocene or Miocene, and discusses its bearing in determining the age of the Puget group.

357 **Leonhard** (A. G.). Occurrence of zinc in northeastern Iowa.

Iowa Acad. Sci., Proc., vol. i, pt. iv, pp. 48–52.

Describes the character and occurrence of the ore and discusses the manner of its deposition.

358 —— Satin spar from Dubuque [Iowa].

Iowa Acad. Sci., Proc., vol. i, pt. iv, pp. 52–55.

Describes the occurrence of calcite in a cave near Dubuque, Iowa.

359 **Leverett** (Frank). [Origin of the "fringe."]

Geol. Soc. Am., Bull., vol. v, p. 17 (7 l.).

In discussion of remarks by W. Upham on the "Origin of the fringe on Long Island."

360 —— [Character of material deposited during the retreat of the ice sheet.]

Geol. Soc. Am., Bull., vol. v, p. 84 (¼ p.).

In discussion of paper by Warren Upham on "Evidences of the derivation of the kames, eskers, and moraines of the North American ice sheet, chiefly from its englacial drift."

360*a* —— Changes of drainage in the Rock River Basin, in Illinois.

Abstracts: Am. Assoc. Adv. Sci., Proc., vol. xlii, p. 179 (⅜ p.); Am. Geol., vol. xii, p. 179 (⅜ p.).

360*b* —— Evidences of the diversity of the older drift in northwestern Illinois.

Abstract: Am. Geol., vol. xii, p. 229 (⅛ p.).

360*c* —— **Chamberlin** (T. C.) and. Further studies of the drainage features of the Upper Ohio Basin.

Am. Jour. Sci., 3d ser., vol. xlvii, pp. 247–283.

See Chamberlin (T. C.) and Leverett (Frank), No. 63.

360*d* **Lewis** (Henry Carvill). Papers and notes on the Glacial geology of Great Britain and Ireland. Edited by Henry W. Crosskey.

London: Longmans, Green & Co., 1894.

Abstracts: Am. Jour. Sci., 3d ser., vol. xlviii, pp. 73–74; Jour. of Geol., vol. ii, pp. 747–750, by T. C. Chamberlin.

361 **Lincoln** (D. F.). The amount of glacial erosion in the Finger Lake region of New York.

Am. Jour. Sci., 3d ser., vol. xlvii, pp. 105–113.

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xlii, pp. 177–178.

Describes the outcrops of Silurian and Devonian strata and the topography and glaciated deposits in this region. Discusses the origin of the trough-like lake basins and includes a bibliography.

362 **Lindgren** (Waldemar). Sacramento folio. California.

U. S. Geol. Surv., Geologic Atlas of the United States, folio 5.

Describes the geology of the gold belt of California and the occurrence of the auriferous slates, igneous rocks, Tertiary and Pleistocene strata, and the gold, copper, and iron deposits of the region. Includes topographic, colored areal geologic, economic geologic, and structure section maps.

363 —— The gold-silver mines of Ophir, Cal.

U. S. Geol. Surv., 14th Ann. Rept., pt. 2, pp. 243–284, pls. xvii–xviii.

Describes the topographic and geologic features of the region, the petrographic characters of the granodiorite, amphibolite, and dike rocks, the different vein systems, the mineralogic characters of the ores, and the distribution of gold and silver in the veins. Discusses the movements along the veins and gives the author's conclusions.

364 —— An auriferous conglomerate of Jurassic age from the Sierra Nevada.

Am. Jour. Sci., 3d ser., vol. xlviii, pp. 275–280.

Describes the lithologic character and the structure of the Mariposa and Calaveras formations of Jurassic and Carboniferous age occurring in Placer County, Cal., and gives a summary of the author's conclusions.

365 —— and **Turner** (H. W.). Placerville folio. California.

U. S. Geol. Surv., Geologic Atlas of the United States, folio 3.

Describes the general geology of the gold belt of California and the occurrence and distribution of the auriferous slates and Neocene gold-bearing gravels of the region. Includes topographic, colored areal geologic, economic geologic, and structure section maps.

366 **Lonsdale** (E. H.). Southern extension of the Cretaceous in Iowa.

Iowa Acad. Sci., Proc., vol. i, pt. iv, pp. 39–43.

Mentions some of the exposures of the Cretaceous in Iowa and describes the topography of the region in which they occur and the removal of portions of these beds by the glacial ice sheet.

367 —— Topography of the granite and porphyry region of Missouri.

Iowa Acad. Sci., Proc., vol. i, pt. iv., pp. 43–48.

Describes the topography of the region and its relation to the Archean and Cambrian rocks of the region.

368 **Luther** (D. D.). Report on the geology of the Livonia salt shaft [New York].

N. Y. State Mus., 47th Ann. Rept., pp. 219–324.

Describes the geologic formations passed through in sinking the Livonia shaft to a depth of 1,432 feet and gives the vertical section displayed and a list of fossils found at various horizons.

369 **Lyman** (Benjamin Smith). Age of the Newark brownstone.

Am. Phil. Soc., Proc., vol. xxxiii, pp. 5–10.

Abstract: Am. Geol., vol. xiii, p. 284 (6 l.).

Quotes from several descriptions of fossils found at this horizon, which indicate that some of these beds may be of Paleozoic rather than of Mesozoic age.

370 —— Some new red horizons.

Am. Phil. Soc., Proc., vol. xxxiii, pp. 192–215, three plates.

Abstracts: Jour. of Geol., vol. ii, pp. 644–645; Am. Nat., vol. xxviii, pp. 878–879.

Reviews the evidences on which the red horizons east of the Blue Ridge have been assigned to the Mesozoic. Describes the outcrops in Connecticut, New Jersey, Pennsylvania, Virginia, and North Carolina, and gives lists of all the fossils found at different localities in these States. Considers that certain of these beds may be of Permian age.

371 —— Some Coal Measure sections near Peytona, W. Va.

Am. Phil. Soc., Proc., vol. xxxiii, pp. 282–309, two maps and cross sections.

Describes a large number of exposures of the Coal Measures in this region.

372 —— The name "Newark" in American stratigraphy.

Jour. of Geol., vol. ii, pp. 59–61.

Differs with G. K. Gilbert as to the use of the term "Newark." See No. 217.

M.

373 **McCalley** (Henry). Bauxite mining.

Science, vol. xxiii, pp. 29–30.

Describes the character and chemical composition of some of the Georgia and Alabama bauxite deposits.

374 **McCallie** (S. W.). A preliminary report on the marbles of Georgia.

Ga. Geol. Surv., Bull. No. 1, p. 87.

Gives a historical sketch of the marble industry, discusses the origin of limestones, and describes the marbles of Fannin, Gilmer, Pickens, and Cherokee counties, Ga.

375 **McCarn** (H. L.). Notes on the geology of the gold field of Cripple Creek, Colorado.

Science, vol. xxiii, pp. 31–35.

Describes the structure of the ore bodies and discusses the evidence as to their origin.

376 **McGee** (W J). The potable waters of eastern United States.

U. S. Geol. Surv., 14th Ann. Rept., pt. 2, pp. 1–47, figs. 1–5.

Describes the occurrence and source of potable waters and the methods of obtaining and utilizing cistern water, stream water, ground water, and phreatic water supplies.

377 **McGee** (W J). [Extra-morainic drift of New Jersey.]

Geol. Soc. Am., Bull., vol. v, pp. 17–18.

Discusses the evidences which have been found of the existence of glacial deposits south of the terminal moraine in New Jersey.

378 —— [Terrestrial submergence southeast of the American Continent.]

Geol. Soc. Am., Bull., vol. v, pp. 21–22.

In discussion of paper by J. W. Spencer on the same subject.

379 —— [Cenozoic history of eastern Virginia and Maryland.]

Geol. Soc. Am., Bull., vol. v, p. 24 (⅔ p.).

In discussion of paper by N. H. Darton on the same subject.

380 —— [On the Columbia and Lafayette formations.]

Geol. Soc. Am., Bull., vol. v, p. 100 (⅔ p.).

Describes the relations of the Columbia and Lafayette formations, in the discussion of a paper by Warren Upham on "The succession of Pleistocene formations in the Mississippi and Nelson River basins."

381 —— Graphic comparison of post-Columbia and post-Lafayette erosion.

Abstracts: Am. Assoc. Adv. Sci., Proc., vol. xlii, p. 179 (⅓ p.); Am. Geol., vol. xii, p. 180 (⅓ p.).

382 —— Glacial canyons.

Jour. of Geol., vol. ii, pp. 350–364.

Discusses the effects of the several agencies involved in the development of glacial canyons.

383 —— [Correlation of clastic rocks.]

Int. Cong. Geol., Compte Rendu, 5th session, pp. 160–166.

Explains the principles of correlation developed in the study of the Coastal Plain and Atlantic and Gulf slopes of the United States.

384 —— [Classification of Pleistocene deposits.]

Int. Cong. Geol., Compte Rendu, 5th session, pp. 198–207.

Remarks on the importance of land forms as products of geologic agencies in Pleistocene time, discusses the claims of genetic classification, and presents the author's scheme of a classification of the Pleistocene deposits.

385 —— The Prairies. Itinerary from Kansas City, Mo., to Chicago, Ill.

Int. Cong. Geol., Compte Rendu, 5th session, pp. 449–452.

Describes the surface features of the prairies and the local geology between the points named along the route traversed by the western excursion of the International Congress of Geologists.

386 —— The Lafayette formation.

Review: Jour. of Geol., vol. ii, pp. 435–439, by J. W. Spencer.

Abstract: Am. Geol., vol. xiv, pp. 115–116.

Noticed in Bibliography and Index for 1892 and 1893.

387 —— **Williams** (G. H.), **Willis** (B.) and **Darton** (N. H.). Geology of Washington and vicinity.

Int. Cong. Geol., Compte Rendu, 5th session, pp. 219–251.

Describes the general and local physiography, the rocks of the Piedmont Plateau and the Coastal Plain, and the crystalline and clastic rocks of the immediate vicinity of Washington.

388 **Manson** (Marsden). A reply to "Causes and conditions of glaciation."

Am. Geol., vol. xiv, pp. 192–194 (correspondence).

Reviews statements of a recent paper on the same subject.

389 **Marcou** (Jules). Growth of knowledge concerning the Texas Cretaceous.

Am. Geol., vol. xiv, pp. 98–105.

Reviews the previous work on the Cretaceous deposits of Texas and gives a table of "Evolution of knowledge of the Texas Cretaceous."

390 —— Note on the geological map of the State of New York.

Am. Geol., vol. xiv, pp. 257–259 (correspondence).

Quotes from the 12th Ann. Report of the State Geologist for the year 1892, with comments.

391 **Marsh** (Othniel C.). Restoration of Camptosaurus.

Am. Jour. Sci., 3d ser., vol. xlvii, Appendix, pp. 245–246, pl. vi; Geol. Mag., dec. iv., vol. i, pp. 193–195, pl. vi; Sci. Am. Suppl., vol. xxxvii, pp. 15209–15210.

This restoration is based on a type specimen of Camptosaurus dispar from the Atlantosaurus beds of Wyoming.

392 —— Restoration of Elotherium.

Am. Jour. Sci., 3d ser., vol. xlvii, Appendix, pp. 407–408, pl. ix; Geol. Mag., dec. iv, vol. i, pp. 294–295, pl. x.

The restoration is based on type specimen of Elotherium crassum from the Miocene beds of Colorado and others from the same horizon of South Dakota.

393 —— A new Miocene mammal.

Am. Jour. Sci., 3d ser., vol. xlvii, Appendix, p. 409.

Describes and figures the last upper molar of an animal called Heptacodon curtus from the Miocene of South Dakota.

394 —— Footprints of vertebrates in the Coal Measures of Kansas.

Am. Jour. Sci., 3d ser., vol. xlviii, Appendix, pp. 81–84, pls. ii–iii; Geol. Mag., dec. iv, vol. i, pp. 337–339, pl. xi; Sci. Am. Suppl., vol. xxxviii, pp. 15491–15492.

Describes five new genera and species from the Carboniferous of Kansas.

395 —— The typical Ornithopoda of the American Jurassic.

Am. Jour. Sci., 3d ser., vol. xlviii, Appendix, pp. 85–90, pls. iv–vii.

Describes Camptosaurus, Dryosaurus, Laosaurus, and Nanosaurus.

396 —— Eastern division of the Miohippus beds, with notes on some of the characteristic fossils.

Am. Jour. Sci., 3d ser., vol. xlviii, Appendix, pp. 91–94.

Describes two new genera and five new species from the Miocene beds of Oregon.

397 —— Miocene Artiodactyla from the eastern Miohippus beds.

Am. Jour. Sci., 3d ser., vol. xlviii, Appendix, pp. 175–178, figs. 1–7.

Describes one new genus and a new species from the Miocene of South Dakota.

398 **Marsh** (Othniel C.). Description of Tertiary Artiodactyla.

Am. Jour. Sci., 3d ser., vol. xlviii, Appendix, pp. 259–274, figs. 1–34.

Review: Am. Nat., vol. xxviii, pp. 867–869.

Describes 13 new species and 3 new genera of ungulate mammals from the Miocene.

399 —— A gigantic bird from the Eocene of New Jersey.

Am. Jour. Sci., 3d ser., vol. xlviii, p. 344.

Describes Barornis regens from the upper marl beds.

400 —— A new Miocene tapir.

Am. Jour. Sci., 3d ser., vol. xlviii, p. 348 (⅓ p.).

Describes Tanyops undans from the Miocene of South Dakota.

401 —— [Correlation of clastic rocks.]

Int. Cong. Geol., Compte Rendu, 5th session, pp. 156–159.

Remarks on the study of the succession of vertebrate life and presents a columnar section to illustrate the vertebrate life in America.

402 **Marsters** (Vernon F.) and **Kindle** (E. M.). Geologic literature of Indiana (stratigraphic and economic).

Ind. Acad. Sci., Proc., 1893, pp. 156–191.

Comprises a bibliography and index of stratigraphic and economic geologic literature of Indiana.

403 **Matthew** (G. F.). Post-Glacial faults at St. John, New Brunswick.

Am. Jour. Sci., 3d ser., vol. xlviii, pp. 501–503, pl. xi.

Describes briefly faults of small displacement occurring in post-Glacial deposits.

404 —— Movements of the earth's crust at St. John, New Brunswick, in post-Glacial times.

New Brunswick Nat. Hist. Soc., Bull., No. xii, pp. 34–42.

Describes the character of certain recent faults in this vicinity, and gives a table showing the amount of each displacement.

405 —— The outlets of the St. John River [New Brunswick].

New Brunswick Nat. Hist. Soc., Bull., No. xii, pp. 43–62.

Describes the earlier outlets of this river and discusses the genesis of the valleys which form the drainage system of the region.

406 —— Ancient myriapods.

Can. Rec. Sci., vol. vi, pp. 93–99.

Reviews the previous description of fossil myriapods and gives a brief description of some of the characteristics of the several families.

406*a* —— Illustrations of the fauna of the St. John group, No. VIII.

Abstracts: Am. Jour. Sci., 3d ser., vol. xlviii, pp. 72–73 (⅔ p.); Am. Geol., vol. xiv, pp. 187–188.

Noticed in Bibliography and Index for 1892 and 1893.

407 **Matthew** (W. D.). The intrusive rocks near St. John, New Brunswick.

N. Y. Acad. Sci., Trans., vol. xiii, pp. 185–203, pl. v.

Describes the general character of the Laurentian rocks of the region and the petrographic characters of the granite-diorite and gabbro, and gives a summary of results.

408 **Matthew** (W. D.). The crystalline rocks near St. John, New Brunswick, Canada.

New Brunswick Nat. Hist. Soc., Bull., No. xii, pp. 16–33.

Describes the general character of the formations in this vicinity and discusses the origin and composition of igneous rocks. Describes the granite, gabbro, and volcanic rocks of the region.

408*a* —— Antennæ in trilobites.

Abstract: Am. Nat., vol. xxviii, pp. 266–267 (⅜ p.).

Noticed in Bibliography and Index for 1892 and 1893.

409 **Mawby** (W.). Notes on the Triassic rocks of New Jersey, United States of America.

Liverpool Geol. Soc., Proc., vol. vii, pp. 206–212.

Describes the general distribution of Triassic rocks of eastern North America and compares them with the Trias of Europe. Describes the general character and distribution of the glacial deposits of New Jersey.

410 **Meissner** (C. A.). Analysis of limestones and dolomites of the Birmingham (Ala.) district.

Ala. Ind. and Sci. Soc., Proc., vol. iv, pp. 12–23.

Describes the occurrence of limestone and dolomite in this region and gives chemical analyses of some of these rocks.

411 **Memminger** (C. J.). Florida kaolin deposits.

Eng. and Mg. Jour., vol. lvii, p. 436.

Brief description of kaolin deposits of Lake County, Fla., with a chemical analysis.

412 **Merrill** (George Perkins). [Beaver Creek meteorite.]

Am. Jour. Sci., 3d ser., vol. xlvii, p. 435.

Discusses the microscopic characteristics of this meteorite.

412*a* —— **Emmons** (S. F.) and. Geological sketch of Lower California.

Geol. Soc. Am., Bull., vol. v, pp. 489–514, pl. 19.

See Emmons (S. F.) and Merrill (G. P.), No. 184.

413 **Miller** (S. A.). Paleontology.

Ind. Dept. Geol. and Nat. Res., 18th Rept., pp. 257–333, pls. i–xii.

Describes a large number of new species, mainly from the Carboniferous and Silurian deposits of the Mississippi Valley.

414 —— and **Faber** (C. L). New species of fossils from the Hudson River group, and remarks upon others.

Cin. Soc. Nat. Hist., Jour., vol. xvii, pp. 22–33, pl. i.

Describes seven new species of fossils from the Silurian of Ohio.

415 —— Description of some Cincinnati fossils.

Cin. Soc. Nat. Hist., Jour., vol. xvii, pp. 137–158.

Describes ten new species from the Hudson River group of Ohio and Indiana.

415*a* **Minnesota, Geological and Natural History Survey.** Twenty-first Annual Report.

Abstracts: Am. Geol., vol. xiii, pp. 425-426; Am. Nat., vol. xxviii, p. 593 (⅛ p.).

415*b* **Minor** (J. C., jr.), **Penfield** (S. L.) and. On the chemical composition and related physical properties of topaz.

Am. Jour. Sci., 3d ser., vol. xlvii, pp. 387–396.

See Penfield (S. L.) and Minor (J. C., jr.), No. 449.

416 **Moeller** (W. H.). The Mercur gold deposits in the Camp Floyd district, Utah.

Eng. and Mg. Jour., vol. lvii, p. 51 (correspondence).

Describes the character and structure of the gold deposits.

417 **Mudge** (E. H.). Drainage systems of the Carboniferous area of Michigan.

Am. Geol., vol. xiv, pp. 301–308.

Describes the topography and drainage systems of the Carboniferous area in Michigan and discusses the genesis of the river systems.

N.

418 **Nason** (Frank L.). The economic geology of Albany County [N. Y.].

N. Y. State Mus., 47th Ann. Rept., pp. 459–481, pls. 1–7.

Describes the occurrence of building stones, flagstones, clays, and sand banks in this county.

419 —— Economic geology of Ulster County [N. Y.].

N. Y. State Mus., 47th Ann. Rept., pp. 569–600, pls. 1–5.

Describes the occurrence of Rosendale or natural cement and the building stone and clays of this county.

420 —— Origin of the iron pyrites deposits in Louisa County, Va.

Eng. and Mg. Jour., vol. lvii, pp. 414–416.

Describes the vein formation of these ore bodies, compares them with the New Jersey iron ore deposits, and discusses the evidence as to the origin of the ores, and suggests that they were leached out from the shore rocks at the time of deposition of the inclosing sedimentaries, and were precipitated contemporaneously with the formation of the latter.

421 —— [The lead and zinc deposits of the Mississippi Valley.]

Am. Inst. Mg. Engrs., Trans., vol. xxii, pp. 636–642.

In discussion of paper by W. P. Jenney on the same subject.

422 —— The chemical composition of some of the white limestones of Sussex County, N. J.

Am. Geol., vol. xiii, pp. 154–164.

Gives several chemical analyses of the limestones in this county, and discusses the evidence indicating that the white crystalline limestone and the blue "magnesian" limestone are of contemporaneous origin.

423 —— Summary of facts proving the Cambrian age of the white limestones of Sussex County, N. J.

Am. Geol., vol. xiv, pp. 161–169.

Gives a summary and discussion of the evidences which indicate that the white limestones, heretofore considered to form a part of the Azoic crystalline rocks, belong to the Cambrian formation.

424 **Newell** (Frederick H.) Results of stream measurements.
U. S. Geol. Surv., 14th Ann. Rept., pt. 2, pp. 95–155, figs. 6–24.
Describes the character and methods of obtaining the data and gives the results obtained in different streams in the Western States.

424*a* **New Jersey, Geological Survey.** Annual Report, 1892.
Abstract: Am. Nat., vol. xxviii, pp. 336–337 (½ p.).

424*b* **Niles** (William H.). A geological study of Lake Mohonk and Lake Minnewaska, New York.
Abstract: Am. Geol., vol. xiii, p. 211 (7 l.).

425 **Norton** (William Harmon). Notes on the lower strata of the Devonian series in Iowa.
Iowa Acad. Sci., Proc., vol. i, pt. iv, pp. 22–24.
Divides the series mentioned into four stages, and describes the lithologic character of the beds and mentions some of the contained fossils.

O.

426 **Orton** (Edward). Geological scale and geological structure of Ohic.
Ohio Geol. Surv., vol. vii, pp. 3–44.
Gives a vertical section of the geologic formations of Ohio and describes their character and distribution.

427 —— The clays of Ohio, their origin, composition, and varieties.
Ohio Geol. Surv., vol. vii, pp. 45–68.
Describes the origin of clay beds and their geologic distribution.

428 —— The coal fields of Ohio.
Ohio Geol. Surv., vol. vii, pp. 253–290.
Discusses the origin of coal and describes the various coal seams of the Carboniferous strata in Ohio.

429 —— Geological surveys of Ohio.
Jour. of Geol., vol. ii, pp. 502–516.
Gives a historical sketch of the geological surveys of Ohio.

430 —— From the Ohio River to Chicago. Itinerary.
Int. Cong. Geol., Compte Rendu, 5th session, pp. 291–298.
Describes the region traversed by the Western excursion, with special reference to the gas wells.

431 **Orton** (Edward, jr.). The clay-working industries of Ohio.
Ohio Geol. Surv.,vol. vii, pp. 69–254.
Describes the origin, chemical composition, and physical properties of clay, and gives an account of the clay-working industries.

431*a* **Osann** (A.). Eleolite rocks of Trans-Pecos, Texas.
Abstract: Am. Nat., vol. xxviii, pp. 514–515.
Noticed in Bibliography and Index for 1892 and 1893.

431*b* —— Nepheline-mellilite rocks of Texas.
Abstract: Am. Nat., vol. xxviii, pp. 799–800 (⅓ p.).
Noticed in Bibliography and Index for 1892 and 1893.

432 **Osborn** (H. F.). The evolution of teeth in Mammalia in its bearing upon the problem of phylogeny.

N. Y. Acad. Sci., Trans., vol. xii, p. 187.

Abstract: Am. Geol., vol. xiii, p. 357 (½ p.).

433 —— A division of the eutherian mammals into the Mesoplacentalia and Cenoplacentalia.

N. Y. Acad. Sci., Trans., vol. xiii, pp. 234–237.

Separates these mammals into two groups, one distinctive of the Mesozoic and the other of the Tertiary.

433*a* —— A new suborder of the Ancylopoda.

Abstract: Am. Geol., vol. xiii, p. 357 (9 l.).

Noticed in Bibliography and Index for 1892 and 1893.

433*b* —— and **Wortman** (J. L.). Fossil mammals of the Lower Miocene White River beds; collection of 1892.

Am. Mus. Nat. Hist., Bull., vol. vi, pp. 199–228, pls. ii–iii.

Gives a table showing the succession of species in the White River Miocene. Describes new characters of Rhinoceroses, the osteology of Metamynodon, and the characters of Oreodon and Anthracotherium.

P.

434 **Packard** (R. L.). Variscite from Utah.

Am. Jour. Sci., 3d ser., vol. xlvii, pp. 297–298.

Abstract: Am. Nat., vol. xxviii, p. 873 (5 l.).

Describes the characteristics of this material and gives its chemical analysis.

435 **Palache** (Charles). The soda-rhyolite north of Berkeley, Cal.

Univ. of Cal., Dept. of Geol., Bull., vol. i, pp. 61–72, pl. 5.

Abstract: Am. Nat., vol. xxviii, p. 602 (⅛ p.).

Describes the occurrence, geologic relations, and petrographic and chemical characteristics of a soda-rhyolite occurring in this vicinity.

436 —— The lherzolite-serpentine and associated rocks of the Potrero, San Francisco, Cal.

Univ. of Cal., Dept. of Geol., Bull., vol. i, pp. 161–180.

Describes the outcrops and petrographic character of the serpentine and of an intrusive rock, and discusses their relations to the San Francisco sandstone.

437 —— On a rock from the vicinity of Berkeley [Cal.] containing a new soda amphibole.

Univ. of Cal., Dept., of Geol., Bull., vol. i, pp. 181–192, pls. 10–11.

Describes the minerals and secondary veins of the rock and the microscopic and chemical characters of the amphibole.

438 **Patton** (Horace B.). Microscopic study of some Michigan rocks.

Michigan, Report of State Board of Geol. Surv. for 1891–92, pp. 184–186.

Describes the general characters of the igneous rocks of Michigan, with special mention of diabase altered to kaolin and quartz, and of hornblende picrite.

439 **Pavlow** (A.). [Classification of Pleistocene deposits.]

Int. Cong. Geol., Compte Rendu, 5th session, pp. 195–196.

Discusses the principles of chronologic and genetic classification.

440 **Peale** (Albert C.). Natural mineral waters of the United States.

U. S. Geol. Surv., 14th Ann. Rept., pt. 2, pp. 51–88.

Gives a definition of mineral water, discusses its origin, the source of mineralization, and its geologic and geographic distribution and gives a list of American mineral spring resorts.

441 —— Livingston to the Snake Plains. Itinerary, Bozeman to Butte, Mont.

Int. Cong. Geol., Compte Rendu, 5th session, pp. 365–367.

Describes the geology of the route traversed by the Rocky Mountain excursion between these points.

441*a* —— The Paleozoic section in the vicinity of Three Forks, Montana. With petrographic notes by G. P. Merrill.

Abstract: Am. Geol., vol. xiv, p. 394 (¼ p.).

Noticed in Bibliography and Index for 1892 and 1893.

441*b* **Pearce** (Richard). The occurrence of gold in ores of the Cripple Creek district [Colorado].

Abstract: Eng. and Mg. Jour., vol. lvii, p. 271.

Noticed in Bibliography and Index for 1892 and 1893.

442 **Peckham** (S. F.). On the origin of bitumens; a retrospect.

Am. Jour. Sci., 3d ser., vol. xlviii, pp. 389–395.

Gives an account of observations in different parts of the United States on the occurrence of petroleum and bitumen, and concludes that they have not had a uniform derivation, and discusses the probability of their distillation by metamorphic action.

443 —— Petroleum in southern California.

Science, vol. xxiii, pp. 74–75.

Gives a historical sketch of the development of the petroleum industry in California, and presents a section showing the succession of strata in certain wells.

443*a* **Peet** (C. E), **Salisbury** (R. D.) and. Surface geology. Drift phenomena of the Palisade ridge.

N. J. Geol. Surv., Rept. for 1893, pp. 157–224.

See Salisbury (R. D.) and Peet (C. E.), No. 493.

444 **Penfield** (S. L.). Contributions to the crystallization of willemite.

Am. Jour. Sci., 3d ser., vol. xlvii, pp. 305–309.

Abstract: Am. Nat., vol. xxviii, pp. 873–874 (½ p.).

Describes the crystallographic characters and cleavage of willemite from New Mexico.

445 —— On the crystallization of herderite.

Am. Jour. Sci., 3d ser., vol. xlvii, pp. 329–339.

Abstracts: Am. Geol., vol. xiii, p. 427 (8 l.); Am. Nat., vol. xxviii, p. 871 (½ p.).

Describes the characteristics of herderite from five localities in Maine.

446 **Penfield** (S. L.). Mineralogical notes.

Am. Jour. Sci., 3d ser., vol. xlviii, pp. 114–118.

Describes the crystallographic characters of octahedrite from Arkansas, penfieldite, and the cleavage and parting planes of orthoclase and albite.

446*a* —— Pentlandite.

Abstract: Am. Nat., vol. xxviii, p. 519 (½ p.).

Noticed in Bibliography and Index for 1892 and 1893.

447 —— and **Howe** (W. T. H.). On the chemical composition of chondrodite, humite, and clinohumite.

Am. Jour. Sci., 3d ser., vol. xlvii, pp. 188–206.

Abstracts: Am. Nat., vol. xxviii, pp. 872–873 (⅔ p.); Am. Geol., vol. xiii, pp. 358–359 (¼ p.).

Describes the crystallographic characters of chondrodite from Warsaw and Brewster, N. Y.

448 —— and **Kreider** (D. A.). Mineralogical notes.

Am. Jour. Sci., 3d ser., vol. xlviii, pp. 141–144.

Discusses the identity of hydrofranklinite and chalcophanite.

449 —— and **Minor** (J. C., jr.). On the chemical composition and related physical properties of topaz.

Am. Jour. Sci., 3d ser., vol. xlvii, pp. 387–396.

Abstract: Am. Geol., vol. xiii, p. 427 (10 l.).

Gives a list of the localities from which the specimens examined were obtained and the chemical analyses of some of the specimens, discusses the related physical properties, and compares the characteristics of topaz and herderite.

450 **Penhallow** (D. P.). Note on inter-Glacial plants from the Don Valley [Ontario].

Am. Geol., vol. xiii, pp. 93–95.

Describes Fraxinus quadrangulata Michx., Taxus baccata L. var. canadensis Gray, and Quercus obtusiloba Michx.

451 —— Notes on Erian (Devonian) plants from New York and Pennsylvania.

U. S. Nat. Mus., Proc., vol. xvi, pp. 105–114, pls. ix–xiv.

Describes and figures a number of new species found in Devonian strata at different localities of the States named.

452 **Penrose** (R. A. F., jr.). The superficial alteration of ore deposits.

Jour. of Geol., vol. ii, pp. 288–317.

Discusses the relation of alteration in ore deposits and in country rocks, the agents, method, chemical and physical effects, and depth of alteration, and the characteristics of alteration in iron, manganese, copper, lead, zinc, gold, silver, and other metallic deposits. Describes the formation of haloid compounds in ore deposits in arid regions.

453 **Phillips** (William B.). The phosphate rocks of Tennessee.

Eng. and Mg. Jour., vol. lvii, p. 417.

Describes the character of the phosphate rock of Hickman County, Tenn., and the lithologic character of the associated strata. Gives a typical vertical section of the beds, which are of Devonian age, and chemical analyses of the phosphate.

454 **Phillips** (William B.). On the phosphate rock of Tennessee.

Ala. Ind. Sci. Soc., Proc., vol. iv, pp. 44–48.

Gives a brief description of the phosphate rock and its chemical analysis.

454*a* **Piatt** (W. H. H.), **Haworth** (E.) and. A geologic section along the Verdigris River from the State line to Madison [Kans.].

Kans. Univ. Quart., vol. ii, pp. 115–118.

See Haworth (E.) and Piatt (W. H. H.), No. 257.

455 **Pirsson** (L. V.). On the crystallization of enargite.

Am. Jour. Sci., 3d ser., vol. xlvii, pp. 212–215.

Abstracts: Am. Geol., vol. xiii, p. 359 (5 l.); Am. Nat., vol. xxviii, p. 870 (⅛ p.).

Describes the crystallographic characters of enargite from the Ida and National Belle mines of Colorado.

456 —— On some phonolite rocks from the Black Hills.

Am. Jour. Sci., 3d ser., vol. xlvii, pp. 341–346.

Abstract: Am. Nat., vol. xxviii, pp. 702–703.

Describes the chemical and petrographic characters of phonolite, from the Black Hills.

456*a* —— The geology of Conanicut Island, Rhode Island.

Abstract: Am. Nat., vol. xxviii, pp. 420–421 (½ p.).

Noticed in Bibliography and Index for 1892 and 1893.

457 —— and **Wells** (H. L.). On the occurrence of leadhillite from Missouri, and its chemical composition.

Am. Jour. Sci., 3d ser., vol. xlviii, pp. 219–226.

Describes the occurrence, crystallographic characters, and chemical composition of leadhillite.

458 **Pollard** (C. L.). [Note on fossil leaves from Great Neck, Long Island, N. Y.]

N. Y. Acad. Sci., Trans., vol. xiii, pp. 180–181.

Note on the occurrence of fossil leaves in the Cretaceous on Long Island, N. Y.

459 **Poole** (Henry S.). The Pictou coal field; a geological revision.

Nova Scotian Inst. Sci., Proc. and Trans., 2d ser., vol. i, pp. 227–343, with geologic map and sections.

Describes several faults which occur in this district and the lithologic character of the Cambro-Silurian, Silurian, Devonian, Carboniferous, and Permian beds, and gives the sections exposed in a number of coal mines.

459*a* **Posada** (Juan de la C.). The geology of Carmelo Bay [California].

See Lawson (A. C.), No. 352.

460 **Posepny** (F.). The genesis of ore deposits.

Am. Inst. Mg. Engrs., Trans., vol. xxiii, pp. 197–369, figs. 1–100.

Reviews the general facts and theories concerning the origin of ore deposits, describes the constitution and effects of underground circulating waters, the character of ore deposits occurring in fissures and in soluble rocks, those occurring in distinctly stratified rocks and in crystalline schists and eruptive rocks, and those formed by chemical and mechanical influences of the surface region. Advocates the ascension theory of the formation of ore deposits.

461 **Powell** (John W.). Report of the Director.

U. S. Geol. Surv., 14th Ann. Rept., pt. i, p. 321.

Describes the plans for topography and geology for 1893–94, the progress of geologic work during 1892–93 in classifying and correlating sedimentary and igneous rocks, and gives a summary of the work in terrestrial physics. Includes the administrative reports of topographers and geologists in charge of the various divisions of the U. S. Geological Survey.

462 —— [Correlation of clastic rocks.]

Int. Cong. Geol., Compte Rendu, 5th session, pp. 159–160 (½ p.).

Considers that both physical and biotic evidence must be used in the correlation of rocks.

463 **Pratt** (J. H.). Mineralogical notes on cerrusite, calamine, and zircon.

Am. Jour. Sci., 3d ser., vol. xlviii, pp. 212–215.

Describes the crystallographic characters of cerrusite from Montana, calamine from Colorado, and zircon from Ontario.

464 **Prindle** (L. M.). Note on an apatite crystal from Alexander County, N. C.

Johns Hopkins Univ. Circ., vol. xiii, No. 112, p. 83.

Describes the crystallographic characters of the crystal.

465 **Prosser** (Charles S.). The Devonian system of eastern Pennsylvania and New York.

U. S. Geol. Surv., Bull. No. 120, pp. ix + 81, pls. i–ii, fig. 1.

Describes the lithologic character of the Devonian beds along several section lines in eastern Pennsylvania and New York and gives lists of fossils collected and the author's conclusions.

466 **Pumpelly** (Raphael). Geology of the Green Mountains in Massachusetts.

U. S. Geol. Surv., Monograph xxiii, pp. 34, pls. i–iii, figs. 1–8.

Discusses the structure and correlation of the Archean, Algonkian, Cambrian, and Silurian strata of the region.

467 —— [Correlation of clastic rocks.]

Int. Cong. Geol., Compte Rendu, 5th session, pp. 173–174.

Remarks on the correlation of the deposits of the Lake Superior region.

468 **Purington** (Chester Wells). Geological and topographical features of the region about Atlanta, Ga.

Am. Geol., vol. xiv, pp. 105–108, with map of Georgia and sections.

Describes peculiar topographic forms resulting from the long-continued action of the atmosphere on the red clay and soils, which are the products of the disintegration of the gneiss of the region.

R.

469 **Rand** (Theodore D.). The Sadsbury steatite [Pennsylvania].

Phil. Acad. Nat. Sci., Proc., 1894, pp. 455–460.

Describes the outcrops of steatite occurring in Chester County, Pa.

470 **Randall** (F. A.). Preliminary report on the geology of Cattaraugus and Chautauqua Counties [N. Y.].

N. Y. State Mus., 47th Ann. Rept., pp. 713–719.

Gives diagrammatic, vertical, and cross sections of the strata of these counties, with notes on the distribution of the several formations.

471 **Ransome** (F. Leslie). The eruptive rocks of Point Bonita.

Univ. of Cal., Dept. of Geol., Bull., vol. i, pp. 71–114, pls. 6–7.

Abstracts: Am. Geol., vol. xiv, pp. 321–326; Am. Nat., vol. xxviii, p. 419.

Describes the occurrence and petrographic characters of the spheroidal basalt and diabase, the relations of the eruptive rocks, and the character and occurrence of sedimentary rocks and their relations to the eruptive rocks in this vicinity.

472 —— The geology of Angel Island [California].

Univ. of Cal., Dept. of Geol., Bull., vol. i, pp. 193–233.

Abstract: Jour. of Geol., vol. ii, pp. 863–864.

Describes the sedimentary formations and the occurrence, petrographic character, and contact metamorphism of the fourchite and serpentine rocks, and gives chemical analyses of the fourchite and serpentine.

473 **Rauff** (Hermann). Palæospongiologie. Erster Theil.

Paleontographica, Band. 40, pp. 1–346.

Reviews the literature of the subject and describes species, including a number from the Paleozoic strata of different parts of North America.

474 **Raymond** (R. W.). A new classification of economic geological deposits.

Eng. and Mg. Jour., vol. lviii, pp. 412–413.

Discusses the principles of classification in general and reviews the proposed classification of W. O. Crosby.

475 **Reid** (Harry F.). [On the upward movement within a glacier.]

Geol. Soc. Am., Bull., vol. v, pp. 84–85 (½ p.).

In discussion of paper by W. Upham on "Evidences of the derivation of the kames, eskers, and moraines of the North American ice sheet, chiefly from its englacial drift."

476 **Rickard** (T. A.). [The genesis of ore deposits.]

Am. Inst. Mg. Engrs., Trans., vol. xxiii, pp. 589–591.

In discussion of paper on the same subject by F. Posepny.

477 **Ries** (Heinrich). A Pleistocene lake bed at Elizabethtown, Essex County, N. Y.

N. Y. Acad. Sci., Trans., vol. xiii, pp. 107–109.

Describes the formation of this lake bed and the process of lake filling now going on.

478 —— On some new forms of wollastonite from New York.

N. Y. Acad. Sci., Trans., vol. xiii, pp. 146–147 and 207–208.

Describes the crystallographic characters of this mineral.

479 **Ries** (Heinrich). Microscopic organisms in the clays of New York State.

N. Y. Acad. Sci., Trans., vol. xiii, pp. 165–169.

Contains notes on the occurrence of diatoms in these clays and a list of species found.

480 —— On the occurrence of Cretaceous clays at Northport, Long Island [N. Y.].

School of Mines Quart., vol. xv, pp. 354–355.

Gives a list of fossil plants found in these beds which indicate that they are of Cretaceous age.

481 **Rowley** (R. R.). New species of crinoids and brachiopods from the Missouri Hamilton.

Am. Geol., vol. xiii, pp. 151–154, figs. 1–10.

Describes four new species from the Hamilton beds of Callaway County, Mo.

481*a* **Russell** (Israel C.). Second expedition to Mount St. Elias, in 1891.

Abstract: Am. Geol., vol. xiv, pp. 190–191.

Noticed in Bibliography and Index for 1892 and 1893.

481*b* —— A geological reconnoissance in central Washington.

Abstract: Am. Geol., vol. xiv, pp. 51–52 (½ p.).

Noticed in Bibliography and Index for 1892 and 1893.

481*c* —— Malaspina glacier.

Abstract: Am. Nat., vol. xxviii, pp. 1025–1027.

Noticed in Bibliography and Index for 1892 and 1893.

482 **Rutley** (Frank). On the origin of certain novaculites and quartzites.

Geol. Soc. London, Quart. Jour., vol. l, pp. 377–392, pl. xix.

Abstract: Am. Geol., vol. xiv, p. 253 (⅓ p.).

Quotes from a paper by L. S. Griswold on the novaculites of Arkansas, and discusses the evidences as to the origin of these rocks.

S.

483 **Safford** (James M.). Phosphate-bearing rocks in middle Tennessee; preliminary notice.

Am. Geol., vol. xiii, pp. 107–109.

Describes the lithologic characters of the Devonian strata in which the phosphate occurs and the character of the phosphatic material.

484 **Salisbury** (Rollin D.). Superglacial drift.

Jour. of Geol., vol. ii, pp. 613–632.

Describes the character of superficial drift of alpine glaciers, piedmont glaciers, and of a continental ice sheet.

485 —— The drift: its characteristics and relationships.

Jour. of Geol., vol. ii, pp. 708–724 and 837–851.

Defines drift and describes the thickness, lithologic composition, and structure of the drift, the topography of the drift and drift-covered area, the relation of the drift to the underlying rock, and the characteristics of the rock underlying the drift.

486 **Salisbury** (Rollin D.). Surface geology: the Yellow gravel.

N. J. Geol. Surv., Rept., 1893, pp. 39–72.

Describes the deposition and distribution of the Yellow gravel. Discusses the evidences as to the age of these beds.

487 —— Surface geology: extra-morainic drift.

N. J. Geol. Surv., Rept., 1893, pp. 73–123.

Describes the character and distribution of the drift on the Triassic formation and on the area to the north of it.

488 —— Surface geology: the terminal moraine.

N. J. Geol. Surv., Rept., 1893, pp. 124–151.

Describes the course of the terminal moraine in New Jersey as shown on the map which accompanies the report.

489 —— Surface geology: drift deposits made under the influence of stagnant ice.

N. J. Geol. Surv., Rept., 1893, pp. 152–156.

Describes a peculiar type of terraces formed between a valley ice lobe and the bounding rock slope of the valley.

490 —— [On the twofold division of the Columbia formation.]

Geol. Soc. Am., Bull., vol. v, p. 24 (⅓ p.).

In discussion of paper by N. H. Darton on the "Cenozoic history of eastern Maryland and Virginia."

491 —— [Time break between the Lafayette and Columbia formations.]

Geol. Soc. Am., Bull., vol. v, p. 100 (6 l.).

In discussion of paper on the "Succession of Pleistocene formations in the Mississippi and Nelson River basins," by Warren Upham.

491*a* —— A phase of superficial drift.

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xlii, p. 180 (7 l.).

491*b* —— An illustration of the effect of stagnant ice in Sussex County, N. J.

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xlii, p. 180 (⅜ p.).

492 —— and **Kümmel** (Henry B.). Surface geology: Lake Passaic; an extinct glacial lake.

N. J. Geol. Surv., Rept., 1893, pp. 225–328.

Discusses the classification of shore features and lacustrine deposits and describes the shores of Lake Passaic, its lacustrine deposits, and the history and deformation of the lake basin.

493 —— and **Peet** (Charles E.). Surface geology: drift phenomena of the Palisade ridge.

N. J. Geol. Surv., Rept., 1893, pp. 157–224.

Describes the topographic relations of the ridge, the glacial striæ and erosion, the perched blocks, and other glacial phenomena.

494 **Sardeson** (F. W.) Note on "Nanno."

Am. Geol., vol. xiv, pp. 402–403 (correspondence).

Refers to a previous article and descriptions.

495 **Schuchert** (Charles.) A revised classification of the spire-bearing brachiopods.

Am. Geol., vol. xiii, pp. 102–107.

Describes the family and subfamily characters on which the new classification is based.

495*a* —— Spire-bearing genera of the Paleozoic Brachiopoda, Paleozoic of New York, vol. viii, part ii, fas. i.

Review: Am. Geol., vol. xiii, pp. 128–132.

Gives an abstract of "An Introduction to the study of the genera of the Paleozoic Brachiopoda," by James Hall, assisted by John M. Clarke; Paleontology of New York, vol. viii, part ii, fas. i.

495*b* —— **Diller** (J. S.) and. Discovery of Devonian rocks in California.

Am. Jour. Sci., 3d ser., vol. xlvii, pp. 416–422.

See Diller (J. S.) and Schuchert (C.), No. 154.

496 **Scott** (William B.) Notes on the osteology of Agriochœrus Leidy (Artionyx O. and W.).

Am. Phil. Soc., Proc., vol. xxxiii, pp. 243–251.

Abstract: Am. Nat., vol. xxviii, pp. 952–953 (⅔ p.).

Describes and figures fragmentary skeletons from the White River bad lands of South Dakota and discusses the systematic position of the genus.

497 —— The structure and relationships of Ancodus.

Phil. Acad. Nat. Sci., Jour., 2d ser., vol. ix, pp. 461–497 and 536, pls. xxiii–xxiv.

Describes the dentition, skull, vertebral column, and limbs of A. brachyrhynchus, and discusses the relationships of Ancodus.

498 —— The osteology of Hyænodon.

Phil. Acad. Nat. Sci., Jour., 2d ser., vol. ix, pp. 499–535.

Describes a new species and gives a restoration of Hyænodon and discusses its relationships.

499 —— Notes on the osteology of Ancodus (Hyopotamus).

Geol. Mag., dec. iv, vol. i, pp. 492–493.

Describes the principal characteristics of Ancodus brachyrhynchus from material found in the Tertiary beds of South Dakota.

499*a* —— Mammalia of the Deep River beds.

Abstract: Am. Nat., vol. xxviii, pp. 790–791.

Noticed in Bibliography and Index for 1892 and 1893.

500 —— The later Tertiary lacustrine formations of the West.

Abstracts: Geol. Soc. Am., Bull., vol. v, pp. 594–595; Am. Jour. Sci., 3d ser., vol. xlvii, pp. 139–140 (½ p.); Am. Geol., vol. xiii, pp. 141–142.

Describes the distribution and faunal characteristics of the later Tertiary beds in western United States.

501 **Scudder** (Samuel H.). The effect of glaciation and of the Glacial period on the present fauna of North America.

Am. Jour. Sci., 3d ser., vol. xlviii, pp. 179–187.

In tabular form gives a list of described American Quaternary Coleoptera, showing their locality and the forms to which they are allied, their regional distribution in North America, and the species common to different regions.

502 **Scudder** (Samuel H.). Tertiary Tipulidæ, with special reference to those of Florissant, Colo.

Am. Phil. Soc., Proc., vol. xxxii, pp. 163–245, pls. i–ix.

Abstracts: Am. Jour. Sci., 3d ser., vol. xlvii, p. 481 (½ p.); Am. Nat., vol. xxviii, pp. 951–952.

Gives a historical account and list of the European Tertiary Tipulidæ and description of species from Colorado.

502*a* —— American Tertiary Aphidæ.

Abstract: Am. Nat., vol. xxviii, p. 881 (⅔ p.).

Noticed in Bibliography and Index for 1892 and 1893.

502*b* —— Insect fauna of the Rhode Island coal field.

Abstract: Am. Geol., vol. xiv, p. 330 (⅕ p.).

Noticed in Bibliography and Index for 1892 and 1893.

503 **Seamon** (W. H.). The present condition of the earth's interior as viewed from the standpoint of the nebular hypothesis.

Am. Geol., vol. xiv, pp. 20–25.

Discusses the different theories as to the condition of the interior of the earth.

504 **Selwyn** (Alfred R. C.). Volcanic rocks in the Keewatin.

Science, vol. xxiii, pp. 107–108.

In a letter to Professor Dana, dated Montreal, December 9, 1879, discusses the character of volcanic rocks in pre-Cambrian strata.

505 **Shaler** (Nathaniel Southgate). Pleistocene distortions of the Atlantic seacoast.

Geol. Soc. Am., Bull., vol. v, pp. 199–202.

Abstracts: Am. Jour. Sci., 3d ser., vol. xlvii, p. 138 (½ p.); Am. Geol., vol. xiii, pp. 143–144.

Discusses the evidences of orogenic action in Pleistocene time in the region of Marthas Vineyard, and the extent, character, and origin of the movements.

506 —— Relation of mountain growth to formation of continents.

Geol. Soc. Am., Bull., vol. v, pp. 203–206.

Abstracts: Am. Jour. Sci., 3d ser., vol. xlvii, pp. 138–139 (⅜ p.); Am. Geol., vol. xiii, p. 144 (½ p.).

Describes the limitations as to the positions of mountains, and discusses the origin and occurrence of the broad belt of crust which supports the arches of strata formed by mountain-building forces, and on which the mountains lie in short ridges. Discusses the causes of mountain uplifting above sea level.

507 —— Phonomena of beach and dune sands.

Geol. Soc. Am., Bull., vol. v, pp. 207–212.

Abstracts: Am. Jour. Sci., 3d ser., vol. xlvii, p. 139 (⅜ p.); Am. Geol., vol. xiii, pp. 144–145 (⅜ p.).

Discusses the causes of the resistance of beach sands to erosion, and describes their action in protecting seacoasts from erosion and their source of supply. Describes the resistance of dune sands to the percolation of water and the manner in which the material is transported.

508 **Shaler** (Nathaniel Southgate). On the distribution of earthquakes in the United States since the close of the Glacial period.

Bost. Soc. Nat. Hist., Proc., vol. xxvi, pp. 246–256.

Abstract: Am. Geol., vol. xiv, pp. 396–397 (½ p.).

Discusses the evidences of earthquake shocks indicated by the action of the ocean wave in moving poised blocks and unstable topographic forms along coast lines and by the overturning of unstable bodies on land. Gives the results of observations of these phenomena on the coast lines of the United States.

508*a* —— The origin and nature of soils.

Am. Geol., vol. xiv, pp. 114–115 (½ p.).

Noticed in Bibliography and Index for 1892 and 1893.

508*b* **Sherborn** (Charles Davies). An index to the genera and species of Foraminifera.

Smith. Inst., Misc. Coll., vol. xxxvii, pt. i (a to non) ii+240 pp.

509 **Siebenthal** (C. E.). The geology of Dallas County, Ark.

Ark. Geol. Surv., Ann Rept., 1891, vol. ii, pp. 279–318.

Describes the topographic and geologic features of the county and the occurrence of potter's clay.

510 **Simonds** (Frederick W.). [Glacial geology of Lake Cayuga and vicinity, New York.]

Am. Geol., vol. xiv, pp. 58–62 (correspondence).

Reviews the paper by R. S. Tarr on Lake Cayuga, a rock basin.

511 —— and **Hopkins** (T. C.). The geology of Benton County, Ark.

Ark. Geol. Surv., Ann. Rept., 1891, vol. ii, pp. 1–75.

Describes the topographic features of the county, the drainage and springs, the lithologic character and distribution of the Silurian, Devonian, and Carboniferous formations, and the character and occurrence of economic products.

512 **Simpson** (Charles T.). On some fossil unios and other fresh-water shells from the drift at Toronto, Canada; with a review of the distribution of the Unionidæ of northeastern North America.

U. S. Nat. Mus., Proc., vol. xvi, pp. 591–595.

Gives a list of the fossils collected and discusses the geologic and geographic distribution of the Unionidæ in northeastern North America.

513 **Simpson** (George B.). A discussion of the different genera of Fenestellidæ.

N. Y. State Mus., 47th Ann. Rept., pp. 881–921.

Discusses the relations of the genera and includes remarks on the various genera of Fenestellidæ.

514 —— Glossary and explanations of specific names of Bryozoa and corals described in volume vi, Palæontology of New York, and other reports.

N. Y. State Mus., 47th Ann. Rept., pp. 925–941.

515 **Smith** (Eugene A.). Geological surveys in Alabama.

Jour. of Geol., vol. ii, pp. 275–287.

Gives an account of the operations of the various geological surveys of Alabama.

516 —— The post-Eocene formations of the Coastal Plain of Alabama.

Am. Jour. Sci., 3d ser., vol. xlvii, pp. 285–296.

Describes the Pleistocene, Pliocene, Miocene, and Eocene deposits of Alabama and reviews previous descriptions of these and other beds of the Mississippi Valley.

517 —— Geological map and explanatory chart of Alabama.

Ala. Geol. Surv., Montgomery, Alabama.

Contains a colored geologic map of the State and a sheet explaining the lithologic character and distribution of the formations.

518 —— **Langdon** (Daniel W., jr.), and **Johnson** (Lawrence C.). On the geology of the Coastal Plain of Alabama, Cretaceous, Tertiary, and post-Tertiary formations.

Ala. Geol. Surv., pp. xxiv+759, pls. i–xxix.

Contains a general sketch of the geology of Alabama and a description of the lithologic and faunal characters, and the distribution in Alabama of the Cretaceous, Tertiary, and post-Tertiary formations.

519 **Smith** (Erastus G.). Artesian wells as a source of water supply.

Sci. Am. Suppl., vol. xxxvii, pp. 15065–15066.

Discusses briefly the geologic conditions essential to the existence of artesian wells and the chemical character of artesian water supply.

520 **Smith** (George Otis). Notes on crystals of scapolite, gypsum, and fayalite recently acquired by the university cabinet.

Johns Hopkins Univ. Circ., vol. xiii, No. 112, pp. 81–83.

Describes the crystallographic characters of the crystals mentioned.

521 **Smith** (James Perrin). The Arkansas Coal Measures in their relation to the Pacific Carboniferous province.

Jour. of Geol., vol. ii, pp. 187–203.

Abstract: Am. Jour. Sci., 3d ser., vol. xlvii. p. 482 (10 l.).

Compares the Coal Measures of Arkansas with the Permo-Carboniferous beds of Kansas and Nebraska and discusses the classification and age of the Arkansas coal beds and the character of the Carboniferous strata in other parts of western United States. Presents a table showing the correlation of the Arkansas Coal Measures with those of the Pacific Carboniferous province.

522 —— The metamorphic series of Shasta County, Cal.

Jour. of Geol., vol. ii, pp. 588–612.

Describes the geologic structure in this county and the lithologic character and fauna of the Carboniferous and Juratrias formations.

523 —— Age of the Auriferous slates of the Sierra Nevada.

Geol. Soc. Am., Bull., vol. v, pp. 243–258.

Abstracts: Am. Geol., vol. xiii, p. 215 (⅛ p.); Am. Nat., vol. xxviii, pp. 414–415 (½ p.).

Reviews the opinions of other writers on this subject and the results shown by recent discoveries and determination of fossil forms from the Carboniferous, Triassic, and Jurassic strata at different localities in the Sierra Nevada. Discusses the correlation of the Mariposa and Aucella-bearing rocks with the Jura of Europe.

524 **Smyth** (C. H., jr.). On gabbros in the southwestern Adirondack region [New York].

Am. Jour. Sci., 3d ser., vol. xlviii, pp. 54–65.

Describes the petrographic characters of the gabbro of the southwest corner of Hamilton County and the contact of the gabbro and gneiss.

525 —— A group of diabase dikes among the Thousand Islands, St. Lawrence River.

N. Y. Acad. Sci., Trans., vol. xiii, pp. 209–214.

Describes the occurrence of the dikes and the microscopic character of the dike rocks.

526 —— Report on a preliminary examination of the general and economic geology of four townships in St. Lawrence and Jefferson counties [N. Y.].

N. Y. State Mus., 47th Ann. Rept., pp. 687–709, with map.

Describes the character of the crystalline and sedimentary rocks of the region, and discusses the evidences as to their stratigraphic relations. Discusses the evidences as to the origin of the iron ores of the region, and describes the talc and marble industries.

527 —— On a basic rock derived from granite.

Jour. of Geol., vol. ii, pp. 667–679.

Abstract: Am. Geol., vol. xiv, p. 195 (10 l.).

Describes the character and origin of the rock and the microscopic and chemical characteristics of the alteration product occurring in hematite deposits of Jefferson County, N. Y.

528 **Smyth** (Henry Lloyd). Relations of the Lower Menominee and Lower Marquette series in Michigan (preliminary).

Am. Jour. Sci., 3d ser., vol. xlvii, pp. 216–223.

Abstract: Am. Geol., vol. xiii, p. 359 (⅓ p.).

Describes the lithologic characters and succession of these two series, discusses their structure and distribution, and gives a summary of conclusions.

529 —— The quartzite tongue at Republic, Mich.

Jour. of Geol., vol. ii, pp. 680–691, figs. 1–5.

Describes the geologic structure of the region and the characteristics of the quartzite and jasper tongues that extend from the main mass of quartzite.

530 **Spencer** (Arthur C.). Occurrence in Iowa of fossiliferous concretions similar to those of Mazon Creek.

Iowa Acad. Sci., Proc., vol. i, pt. iv, p. 55.

Describes the occurrence of plant remains in the Carboniferous of Iowa.

531 **Spencer** (Joseph W.). Deformation of the Lundy Beach and birth of Lake Erie.

Am. Jour. Sci., 3d ser., vol. xlvii, pp. 207–212.

Describes the formation of Lundy Beach and its effect on the drainage of the Great Lakes and gives an estimate of the rate of uplift in the Niagara district.

532 **Spencer** (Joseph W.). The duration of Niagara Falls.

Am. Jour. Sci., 3d ser., vol. xlviii, pp. 455–472

Abstracts: Am. Geol., vol. xiv, p. 204 (7 l.); Am. Nat., vol. xxviii, pp. 859–862.

Reviews the different opinions as to the age of the falls, describes the topography and geology of the region, and discusses the history of the Great Lakes and Niagara River, the age of the falls as shown by terrestrial movements, and the relationship of the falls to geologic time. Gives a summary of conclusions.

533 —— The rock basin of Cayuga Lake [New York].

Am. Geol., vol. xiv, pp. 134–135 (correspondence).

Reviews the evidence indicating that Lake Cayuga occupies a rock basin.

534 —— The age of Niagara Falls.

Am. Geol., vol. xiv, pp. 135–136 (correspondence).

Gives a brief statement of the results of the writer's studies in the region of the Great Lakes.

535 —— A review of the history of the Great Lakes.

Am. Geol., vol. xiv, pp. 289–301, pl. viii.

Discusses the evidence of a former high continental elevation and describes the character of the lake basin, the drainage of the region, the formation of the modern lakes, the history of the Niagara River, and the changes of the outlets of the lakes.

536 —— Terrestrial submergence southeast of the American Continent.

Abstracts: Geol. Soc. Am., Bull., vol. v, pp. 19–21; Am. Geol., vol. xii, p. 168 (⅔ p.); Am. Nat., vol. xxviii, p. 51 (⅔ p.).

Discusses the evidences of a submergence in this region.

537 —— Niagara Falls as a chronometer of geological time.

Abstract: Roy. Soc. of London, Proc., vol. l, pp. 145–148.

Communicated by Prof. T. G. Bonney.

538 —— The Yumuri Valley of Cuba.

Geol. Mag., dec. iv, vol. i, pp. 499–502.

Describes the formation of the valley in Pleistocene time.

538*a* —— The Paleozoic group: The geology of ten counties of northwestern Georgia and resources.

Abstract: Am. Jour. Sci., 3d ser., vol. xlvii, p. 78 (¼ p.).

Review: Jour. of Geol., vol. ii, pp. 335–339, by E. A. Smith.

Noticed in Bibliography and Index for 1892 and 1893.

538*b* —— The drainage of the Great Lakes in the Mississippi by way of Chicago.

Abstract: Am. Nat., vol. xxviii, p. 884 (½ p.), by the author.

538*c* —— The restoration of the Antillean Continent.

Abstract: Am. Nat., vol. xxviii, pp. 881–884, by the author.

539 **Spurr** (J. E.). The iron ores of the Mesabi range [Minnesota].

Am. Geol., vol. xiii, pp. 335–345.

Abstract: Eng. and Mg. Jour., vol. lvii, pp. 583–584.

Describes the structure of the rock formations, the character of the iron-bearing rocks and the changes they have undergone, and discusses the origin of the ore deposits.

540 —— The iron-bearing rocks of the Mesabi range, in Minnesota.

Minn. Geol. and Nat. Hist. Surv., Bull., No. x, pp. viii+259, pls. i–xii.

Abstract: Am. Geol., vol. xiv, pp. 251–252.

Review: Jour. of Geol., vol. ii, pp. 545–546, by T. C. Hopkins.

Describes the structure and stratigraphy of the range and the microscopic character of certain groups of the iron-bearing rocks. Discusses the classification of these rocks and the nature of the agents that have affected them, and the formation, structure, and origin of the ore bodies. Includes a summary statement of the author's conclusions.

541 —— Preliminary report on field work done in 1893.

Minn. Geol. and Nat. Hist. Surv., 22d Ann. Rept., pp. 115–124.

Describes the area mapped and the topographic and geologic methods employed. Discusses the origin and age of the granite of Giants range and describes the schists and Thompson slates of the Keewatin series, the Cretaceous outliers, and the glacial phenomena.

542 —— False bedding in stratified drift deposits.

Am. Geol., vol. xiii, pp. 43–47, figs. 1–2.

Describes the mode of formation of false bedding in a stratified drift deposit in northeastern Minnesota.

543 —— Oscillation and single current ripple marks.

Am. Geol., vol. xiii, pp. 201–206 (correspondence).

Continues the discussion of the evidence of ripple marks described in No. 542.

544 —— The stratigraphic position of the Thompson slates.

Am. Jour. Sci., 3d ser., vol. xlviii, pp. 159–166.

Describes the geographic distribution of this series in eastern Minnesota and their relations to the surrounding rocks. Reviews previous correlations, and discusses the evidences indicating their geologic age and their correlation with the Keewatin of the Mesabi range rather than with the Animikie.

545 **Stanton** (Timothy W.). [On some Mesozoic and Tertiary exhibits at the World's Columbian Exposition.]

Am. Geol., vol. xiii, pp. 289–290 (correspondence).

Refers to the nomenclature of certain specimens from the Cretaceous and their geographic and stratigraphic occurrence.

545*a* —— The Colorado formation and its invertebrate fauna.

Review: Jour. of Geol., vol. ii, pp. 751–752, by H. F. Bain.

Abstracts: Am. Nat., vol. xxviii, p. 510 ($\frac{1}{3}$ p.); Am. Geol., vol. xiv, p. 51 ($\frac{1}{3}$ p.).

Noticed in Bibliography and Index for 1892 and 1893.

545*b* —— **Diller** (J. S.) and. The Shasta-Chico series.

Geol. Soc. Am., Bull., vol. v, pp. 435–464.

See Diller (J. S.) and Stanton (T. W.), No. 155.

545*c* **Stanton** (Timothy W.), **Turner** (H. W.) and. Notes on the geology of the Coast range of California.

Am. Geol., vol. xiv, pp. 92–98.

See Turner (H. W.) and Stanton (T. W.), No. 566.

546 **Stevenson** (John J.). Origin of the Pennsylvania anthracite.

Geol. Soc. Am., Bull., vol. v, pp. 39–70, pl. 2.

Abstract; Am. Nat., vol. xxviii, pp. 160–161.

Describes the coal areas of Pennsylvania and discusses the extent of deformation of the coal basins and the causes of variation in the volatile combustibles of Pennsylvania coals. Discusses the evidences of metamorphism in the formation of coal, reviews the different theories, and gives the author's hypothesis as to the origin of coal beds.

546*a* —— Use of the name "Catskill."

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xlii, p. 171 (⅓ p.).

547 **Storms** (W. H.). Ancient channel system of Calaveras County [Cal.].

Cal. State Mg. Bureau, 12th Rept., pp. 482–492, with two maps and cross sections.

Describes the character and occurrence of the ancient river channels of this region.

548 **Stose** (George W.). A specimen of Ceratiocaris acuminata Hall from the Water Lime of Buffalo, N. Y.

Bost. Soc. Nat. Hist., Proc., vol. xxvi, pp. 369–371.

Gives a description of the specimen.

548*a* **Streeruwitz** (W. H. von). Trans-Pecos, Texas.

Abstract: Am. Nat., vol. xxviii, p. 263.

Noticed in Bibliography and Index for 1892 and 1893.

T.

549 **Tarr** (Ralph S.). The origin of drumlins.

Am. Geol., vol. xiii, pp. 393–407.

Reviews the theories advanced to explain the formation of drumlins. Describes their distribution and discusses the evidences as to their mode of formation. Concludes that they may have been formed by glacial erosion.

550 —— Lake Cayuga a rock basin.

Geol. Soc. Am., Bull., vol. v, pp. 339–356, pl. 14.

Abstracts: Am. Geol., vol. xiii, p. 216 (¼ p.); Am. Nat., vol. xxviii, p. 596 (⅛ p.).

Describes the physical features of the region and reviews opinions of previous writers. Discusses the bearing of observations made and gives the author's summary. Includes a list of 21 papers on the geology of the Finger Lake region.

551 —— Lake Cayuga a rock basin.

Am. Geol., vol. xiv, pp. 194–195 (correspondence).

Refers to certain comments on a previous paper on the same subject.

551*a* **Tarr** (Ralph S.). The economic geology of the United States.
MacMillan & Co., New York.
Reviews: Jour. of Geol., vol. ii, pp. 226–231, by R. A. F. Penrose, jr.; Am. Geol., vol. xiii, pp. 189–192.

551*b* —— Physical geography of Texas.
Abstract: Am. Nat., vol. xxviii, pp. 50–51 (⅝ p.).
Noticed in Bibliography and Index for 1892 and 1893.

552 **Taylor** (F. B.). A reconnoissance of the abandoned shore lines of Green Bay [Michigan and Wisconsin].
Am. Geol., vol. xiii, pp. 316-327, with map.
Describes the character and location of some of the abandoned shore lines of Green Bay.

553 —— A reconnoissance of the abandoned shore lines of the south coast of Lake Superior.
Am. Geol., vol. xiii, pp. 365–383, with map.
Describes the occurrence of the various shore lines, with special reference to the highest shore line, and gives a summary of observations and the author's conclusions.

554 —— The limit of post-Glacial submergence in the highlands east of Georgian Bay [Ontario].
Am. Geol., vol. xiv, pp. 273–289, with map.
Describes the glacial formations of the region and gives a summary and conclusions.

555 —— The ancient strait at Nipissing [Ontario].
Geol. Soc. Am., Bull., vol. v, pp. 620–626, pl. 20.
Abstract: Am. Geol., vol. xiii, pp. 220–221 (⅜ p.).
Describes the Nipissing and other higher level beaches and glacial phenomena of the region and gives the author's conclusions.

555*a* **Texas, Geological Survey.** Fourth Annual Report, 1892.
Abstract: Am. Jour. Sci., 3d ser., vol. xlvii, pp. 319-320 (⅕ p.).

556 **Tight** (W. G.). A glacial ice dam and a limit to the ice sheet in central Ohio.
Am. Nat., vol. xxviii, pp. 488–493, pls. 13–15.
Describes the glacial phenomena in the vicinity of the Licking River, in Licking County, Ohio.

557 —— Contribution to the knowledge of the pre-Glacial drainage of Ohio.
Denison Univ., Bull., vol. viii, pp. 35–62.
Abstract: Am. Geol., vol. xiv, pp. 188–189.
Describes the present drainage systems of the Licking, Muskingum, Hocking, Scioto, and Miami rivers in Ohio, and discusses the evidences of the character of the pre-Glacial drainage of the region.

558 **Tilton** (J. E.). Origin of the present drainage system of Warren County [Iowa].
Iowa Acad. Sci., Proc., vol. i, pt. iv, pp. 31–33.
Describes the drainage systems and concludes that they were marked out in pre-Glacial time.

559 **Todd** (James E.). A preliminary report on the geology of South Dakota.

South Dakota Geol. Surv., Bull. No. 1, pp. 1–172, pls. i–v, figs. 1–2.

Describes the topographic and geologic features of the State, discusses the origin and distribution of rocks of Archean age, and describes the lithologic character and distribution of the sedimentary and eruptive rocks, and gives an account of the economic resources. Includes a preliminary geologic map of South Dakota and a table showing the geologic formations occurring in the State.

560 —— Preliminary report of a reconnoissance in northwestern Minnesota in 1892.

Minn. Geol. and Nat. Hist. Surv., 21st Ann. Rept., pp. 68–78.

Describes the route traversed and the glacial phenomena of the region.

560*a* —— Preliminary report of a reconnoissance in northwestern Minnesota during 1893.

Minn. Geol. and Nat. Hist. Surv., 22d Ann. Rept., pp. 90–96.

Describes the character of the country traversed and the glacial deposits.

561 —— Pleistocene problems in Missouri.

Geol. Soc. Am., Bull., vol. v, pp. 531–548.

Abstracts: Am. Geol., vol. xiii, pp. 216–217 ($\frac{1}{6}$ p.); Am. Nat., vol. xxviii, p. 1027 ($\frac{1}{8}$ p.).

Describes the bowldery drift and loess of the pre-Glacial formations of Missouri, and discusses the subglacial lacustrine and fluviatile hypotheses as to the origin of the Pleistocene formations.

562 **Turner** (Henry W.). Jackson folio. California.

U. S. Geol. Surv., Geologic Atlas of the United States, folio 11.

Describes the relations of land and water, and the dynamic movements affecting the Gold Belt of California in Paleozoic, Mesozoic, and Cenozoic times, and gives a generalized section of the strata. Describes the topography of the Jackson sheet and the character and distribution of the Auriferous slates, igneous rocks, the Tertiary rocks, including the Neocene auriferous gravels, and the Pleistocene beds. Describes the occurrence of the gold-quartz veins, gold-bearing gravels, copper, iron, coal, and building stones. Includes topographic, colored areal geologic, economic geologic, and structure section maps.

563 —— The rocks of the Sierra Nevada.

U. S. Geol. Surv., 14th Ann. Rept., pt. 2, pp. 435–495, pls. xlviii–lix, figs. 49–51.

Describes the several divisions of the Auriferous slate series and the overlying Chico, Tejon, Ione, Neocene, and Pleistocene deposits. Describes the character and occurrence of the intrusive and extrusive igneous rocks.

564 —— Geological notes on the Sierra Nevada.

Am. Geol., vol. xiii, pp. 228–249 and 297–316.

Describes the characteristics of each of the sedimentary formations recognized in the Sierra Nevada, ranging in age from the Silurian to Pleistocene. In the second part the author describes the occurrence and structure of the intrusive and extrusive igneous rocks.

665 **Turner** (Henry W.). Notes on the gold ores of California.

Am. Jour. Sci., 3d ser., vol. xlvii, pp. 467–473.

Describes the veins of the Auriferous slate series, the veins in granite, and the occurrence of gold with albite, barite, calcite, quartz in rhyolite, and cinnabar.

565*a* —— **Lindgren** (W.) and. Placerville folio. California.

U. S. Geol. Surv., Geologic Atlas of the United States, folio 3.

See Lindgren (W.) and Turner (H. W.), No. 365.

566 —— and **Stanton** (T. W.). Notes on the geology of the Coast ranges of California.

Am. Geol. xiv, pp. 92–98.

Discusses the evidence indicating the conformability of the Chico and Tejon series at New Idria, Cal., and gives a list of fossils from Tejon strata collected in Fresno, Sonomo, Lake, and Yulo counties.

567 **Tuttle** (E. G.). The Sabinas coal field [Mexico].

Eng. and Mg. Jour., vol. lviii, pp. 390–392.

Describes the coal seams and the character of the coal, and gives its chemical analyses. Accompanied by a geologic sketch map and cross sections of the region.

568 **Tyrrell** (J. Burr). Notes on the Pleistocene of the Northwest Territories of Canada, northwest and west of Hudson Bay.

Geol. Mag., dec. iv, vol. i, pp. 394–399.

Abstract: Am. Geol., vol. xiv, pp. 338–340.

Describes the lithologic characters of the Cambrian, pre-Cambrian, and glacial deposits of this region, and presents a map of the Territories.

U.

569 **Udden** (J. A.). Erosion, transportation, and sedimentation performed by the atmosphere.

Jour. of Geol., vol. ii, pp. 318–331.

Abstract: Am. Nat., vol. xxviii, pp. 953–954.

Compares the erosive power of air and water and describes the conditions favorable to the erosion and transportation of the earth's material by wind and the character of the deposits thus formed.

570 **Ulrich** (E. O.). New and little known Lamellibranchiata from the Lower Silurian rocks of Ohio and adjacent States.

Ohio Geol. Surv., vol vii, pp. 627–693.

Describes and figures fossils from the Lower Silurian.

570*a* **United States Geological Survey**. Eleventh Annual Report, 1889–90.

Abstract: Am. Nat., vol. xxviii, p. 336 (¼ p.).

570*b* —— Twelfth Annual Report, 1890–91.

Abstract: Am. Geol., vol. xiv, pp. 113–114.

570*c* **United States National Museum**. Report, 1892.

Abstract: Am. Nat., vol. xxviii, pp. 866–867 (⅛ p.).

571 **Upham** (Warren). Wave-like progress of an epeirogenic uplift.
Jour. of Geol., vol. ii, pp. 383–395.
Discusses the evidences of an epeirogenic movement in the northern two-thirds of North America in late Tertiary and Quaternary times.

572 —— Marine shell fragments in drumlins near Boston [Mass.].
Am. Jour. Sci., 3d ser., vol. xlvii, pp. 238–239 (communicated).
Mentions fossils found in drumlins near Boston and considers them pre-Glacial.

573 —— Diversity of the glacial drift along its boundary.
Am. Jour. Sci., 3d ser., vol. xlvii, pp. 358–365.
Abstract: Am. Geol., vol. xiii, p. 223 (¾ p.).
Describes the early and later drift of the Mississippi Valley, and discusses the oscillations of the boundary of the ice sheet during its general recession.

574 —— British drift theories.
Am. Geol., vol. xiii, pp. 275–279.
Reviews the theories advanced by certain English writers to explain the formation of drift deposits.

575 —— Causes and conditions of glaciation.
Am. Geol., vol. xiv, pp. 12–20.
Reviews the recent literature on the origin and duration of the Glacial period, and remarks on the evidences of great erosion of the Lafayette formation in the United States in early Quaternary time.

576 —— The Niagara gorge as a measure of the post-Glacial period.
Am. Geol., vol. xiv, pp. 62–64 (correspondence).
Reviews the evidences indicating the extent of the glacial Lakes Warren and Algonquin and their bearing on the probable volume of the Niagara River.

577 —— The Madison type of drumlins.
Am. Geol., vol. xiv, pp. 69–83, with map, pl. iii, figs. 4–7.
Abstract: Am. Geol., vol. xiii, pp. 222–223 (9 l.).
Describes drumlins with nucleal stratified sand in Massachusetts, and gives a more detailed description of similar drumlins in the vicinity of Madson, Wis.

578 —— Tertiary and early Quaternary baseleveling in Minnesota, Manitoba, and northwestward.
Am. Geol., vol. xiv, pp. 235–246.
Abstracts: Jour. of Geol., vol. ii, p. 754 (½ p.); Am. Geol., vol. xiv, p. 199 (⅛ p.)
Describes the Tertiary and Quaternary baseleveling and the resultant topographic forms in this region. Discusses the evidence of the direction of the drainage during this period and the relationship of the later baseleveling to the Ice age.

579 —— Evidence of superglacial eskers in Illinois and northward.
Am. Geol., vol. xiv, pp. 403–405 (correspondence).
Discusses certain glacial phenomena in Illinois and Minnesota.

580 **Upham** (Warren). Quaternary time divisible into three periods—the Lafayette, Glacial, and Recent.

Am. Nat., vol. xxviii, pp. 979–988.

Abstract: Am. Geol., vol. xiv, p. 203 (⅓ p.).

Reviews the previous opinions on the duration of the geologic subdivisions mentioned and discusses the classification proposed.

581 —— Preliminary report of field work during 1893 in northeastern Minnesota, chiefly relating to the glacial drift.

Minn. Geol. and Nat. Hist. Surv., 22d Ann. Rept., pp. 18–66.

Describes the topography and the Archean outcrops of the region. Discusses the evidences of Cretaceous beds underlying the drift, and describes the glacial deposits.

582 —— The origin of drumlins.

Bost. Soc. Nat. Hist., Proc., vol. xxvi, pp. 2–17.

Abstract: Am. Nat., vol. xxviii, p. 596 (⅛ p.).

Describes the various forms of drumlins and their areal distribution and reviews the previous theories as to their origin. Considers them accumulations from englacial drift. Compares them with moraines, kames, and eskers.

583 —— Deflected glacial striæ in Somerville [Mass.].

Bost. Soc. Nat. Hist., Proc.. vol. xxvi, pp. 33–42.

Describes the occurrence of glacial striæ and gives their observed courses at different points in the vicinity of Somerville, Mass.

584 —— The fishing banks between Cape Cod and Newfoundland.

Bost. Soc. Nat. Hist., Proc., vol. xxvi, pp. 42–48; Am. Jour. Sci., 3d ser., vol. xlvii, pp. 123–129.

Abstract: Am. Geol., vol. xii, pp. 190–191 (½ p.).

Describes the fishing banks of this region and discusses the evidences of a long-continued uplift at the close of the Tertiary period.

585 —— [Extra-morainic drift of the Delaware Valley.]

Geol. Soc. Am., Bull., vol. v, pp. 16–17 (½ p.).

In discussion of papers by A. A. Wright and E. H. Williams, jr., on the glaciated regions of New Jersey and Pennsylvania.

586 —— [Terrestrial submergence southeast of the American Continent.]

Geol. Soc. Am., Bull., vol. v, p. 22 (¼ p.).

In discussion of paper by J. W. Spencer on the same subject.

587 —— Evidences of the derivation of the kames, eskers, and moraines of the North American ice sheet, chiefly from its englacial drift.

Geol. Soc. Am., Bull., vol. v, pp. 71–86.

Abstract: Am. Geol., vol. xii, p. 169 (¾ p.).

Describes glacial phenomena of Long Island, near Rochester, and in portions of North Dakota and Manitoba, which are considered typical examples of the transportation and deposition of the materials of kames, eskers, and moraines.

588 **Upham** (Warren). The succession of Pleistocene formations in the Mississippi and Nelson River basins.

Geol. Soc. Am., Bull., vol. v, pp. 87–100.

Abstract: Am. Geol., vol. xii, pp. 170–171 (¾ p.).

Describes the Lafayette formation, the glacial drift and marginal moraines, and the loess and other modified drift deposits of the Mississippi Valley and Lake Agassiz and its deltas. Discusses the evidences of elevation prior and subsequent to the Glacial epoch.

589 —— Pleistocene climatic changes.

Geol. Mag., dec. iv, vol. i, pp. 340–349.

Abstract: Am. Nat., vol. xxviii, p. 886 (⅓ p.).

Reviews the history of the Glacial period in North America and discusses the causes of the climatic changes.

589*a* —— Tertiary and Quaternary stream erosion of North America.

Abstracts: Am. Assoc. Adv. Sci., Proc., vol. xlii, pp. 181-183; Am. Geol., vol. xii, pp. 180-181 (½ p.).

V.

590 **Van Hise** (Charles R.). Summary of current pre-Cambrian North American literature.

Jour. of Geol., vol. ii, pp. 109–118 and 444–454.

Reviews recent papers on the pre-Cambrian strata of North America.

591 —— The pre-Cambrian rocks of North America.

Int. Cong. Geol., Compte Rendu, 5th session, pp. 110–150.

This paper is condensed from the final chapter of Bulletin No. 86 of the U. S. Geologic Survey, Correlation Papers, Archean and Algonkian, and noticed in Bibliography and Index for 1892 and 1893.

592 —— [Correlation of clastic rocks.]

Int. Cong. Geol., Compte Rendu, 5th session, pp. 167, 172, and 173.

Remarks on the methods employed in the correlation of pre-Cambrian rocks.

593 —— Excursion to Lake Superior: pre-Cambrian geology of the Lake Superior region.

Int. Cong. Geol., Compte Rendu, 5th session, pp. 489–512.

Describes the relations of the Basement Complex, Lower Huronian, Upper Huronian, and Cambrian in this region, and gives the author's general conclusions. Gives a list of 27 papers referring to the geology of the Lake Superior region.

594 —— The succession in the Marquette iron district of Michigan.

Abstract: Geol. Soc. Am., Bull., vol. v, pp. 5–6.

Describes the stratigraphic relations of the formations of the region.

595 —— Character of folds in the Marquette iron district.

Abstract: Am. Assoc. Adv. Sci., Proc., vol. xlii, p. 171 (⅛ p.).

The folding is described as resembling the fan structure of the Alps, except that it is a synclinorium rather than an anticlinorium.

595*a* —— Correlation papers: Archean and Algonkian.

Abstract: Am. Nat., vol. xxviii, p. 944 (⅜ p.).

Noticed in Bibliography and Index for 1892 and 1893.

596 **Vermeule** (Cornelius Clarkson). Report on water supply, water power, the flow of streams, and attendant phenomena.

N. J. Geol. Surv., vol. iii, Final Report, pp. 1–352, appendixes i and ii, pp. 1–62.

Gives data concerning the amount of rainfall, evaporation, and stream gaugings of the drainage systems of New Jersey, and describes the process of stream pollution.

597 —— Water supply and water power.

N. J. Geol. Surv., Rept., 1893, pp. 373–385, with map.

Describes the pollution of the Passaic and other rivers of New Jersey, and gives the location and capacity of certain localities to furnish water supply in the future.

W.

598 **Wadsworth** (M. E.). A sketch of the geology of the iron, gold, and copper districts [Michigan].

Michigan, Rept. of the State Board of Geol. Surv., 1891 and 1892, pp. 79–174.

Describes the general succession of the formations in Michigan, the lithologic character of the rocks associated with the iron ore bodies, and those of the gold and copper deposits.

599 **Wahnschaffe** (Felix). [Classification of Pleistocene deposits.]

Int. Cong. Geol., Compte Rendu, 5th session, pp. 195 and 196–197.

Considers a chronologic classification possible for the Pleistocene deposits of North Germany.

600 **Walcott** (Charles Doolittle). Notes on the Cambrian rocks of Pennsylvania, from the Susquehanna to the Delaware.

Am. Jour. Sci., 3d ser., vol. xlvii, pp. 37–41.

Abstract: Am. Nat., vol. xxviii, pp. 950–951.

Describes the lithologic and paleontologic characteristics of the Cambrian beds of Lancaster County and of the northern belt of limestone in Pennsylvania and New Jersey. Concludes that the basal quartzite is the same from Vermont to Alabama, that the basal sandstone in this belt is of Lower Cambrian age, and that the superjacent limestones of the northern part carry the Olenellus fauna, and in the central and southern part the limestones appear to be represented by shales.

601 —— On the occurrence of Olenellus in the Green Pond Mountain series of northern New Jersey, with a note on the conglomerates.

Am. Jour. Sci., 3d ser., vol. xlvii, pp. 309–311.

Mentions the finding of Olenellus in the limestone in this region, and remarks on the occurrence of a conglomerate both under and overlying the limestone, and on the correlation of the conglomerate of this basin of sedimentation with those of another to the west and north.

602 —— Pre Cambrian igneous rocks of the Unkar terrane, Grand Canyon of the Colorado, Arizona.

U. S. Geol. Surv., 14th Ann. Rept., pt. 2, pp. 497–519, pls. lx–lxv, figs. 52–53.

Describes the sections of the Chuar and Unkar terranes and of the Chuar lava butte. Discusses the conditions of deposition and age of these beds and their correlation with other Algonkian strata.

603 **Walcott** (Charles Doolittle). [Correlation of clastic rocks.]

Int. Cong. Geol., Compte Rendu, 5th session, pp. 168–170.

Remarks on the author's methods employed in the correlation of the Cambrian rocks of North America.

604 —— Silurian vertebrate life at Canyon City [Colo.].

Int. Cong. Geol., Compte Rendu, 5th session, pp. 427–428.

Gives a brief description of the character of the ichthyic fauna found in Silurian rocks in the vicinity of Canyon City, Colo.

605 —— Itinerary, Niagara Falls to New York City.

Int. Cong. Geol., Compte Rendu, 5th session, pp. 459–463.

Describes the geology along the railroad from Niagara Falls to New York City.

606 —— [Terrestrial submergence southeast of the American Continent.]

Geol. Soc. Am., Bull., vol. v, p. 22 (½ p.).

In discussion of paper by J. W. Spencer on the same subject.

607 —— Paleozoic intraformational conglomerates.

Geol. Soc. Am., Bull., vol. v, pp. 191–198, pls. 5–7.

Abstract: Am. Nat., vol. xxviii, p. 1023 (½ p.).

Gives a definition of the term intraformational conglomerate and describes localities in Canada, Vermont, New York, Pennsylvania, and Tennessee where they occur, and discusses their origin.

608 —— Geologic time, as indicated by the sedimentary rocks of North America.

Am. Assoc. Adv. Sci., Proc., vol. xlii, pp. 129–169, with map of North America; Smith. Inst., Ann. Rept., 1892–93, pp. 301–334.

Abstract: Am. Nat., vol. xxviii, pp. 793-794.

Describes the growth and geographic conditions of the continent, the mode of formation and distribution of the deposits of the Cordilleran sea. Discusses the duration of Paleozoic time, as indicated by mechanical and chemical sedimentation, and gives an estimate of the duration of the different periods of post-Archean time.

609 —— Note on some appendages of the trilobites.

Geol. Mag., dec. iv, vol. i, pp. 246–251, pl. viii.

Abstracts: Am. Jour. Sci., 3d ser., vol. xlvii, p. 481 (⅓ p.); Am. Nat., vol. xxviii, p. 878 (½ p.).

Refers to the recent discovery of the antennæ of trilobites and compares them with the extremities of certain specimens of Ceraurus, Calymene, and Asaphus.

609*a* —— The North American Continent during Cambrian time.

Abstract: Am. Geol., vol. xiv, pp. 116–117.

Noticed in Bibliography and Index for 1892 and 1893.

610 **Walker** (T. L.). Notes on nickeliferous pyrite from Murray mine, Sudbury, Ontario.

Am. Jour. Sci., 3d ser., vol. xlvii, pp. 312–314.

Describes this mineral and gives its chemical analysis.

611 **Wallace** (Alfred R.). The Ice age and its work.

Pop. Sci. Mo., vol. vliv, pp. 681–689, 781–791, and vol. xlv, pp. 40–50 and 244–258.

Describes glacial phenomena of Europe and North America.

611*a* **Ward** (Lester F.). Principes et méthodes d'étude de corrélation au moyen des plantes fossiles.

Int. Cong. Geol., Compte Rendu, 5th session, pp. 97–109.

Abstract: Am. Geol., vol. xiv, pp. 334–335 (⅔ p.).

Published in English in American Geologist, vol. ix, p. 34, and noticed in Bibliography and Index for 1892 and 1893.

612 —— [Correlation of clastic rocks.]

Int. Cong. Geol., Compte Rendu, 5th session, pp. 167–168.

Gives a brief summary of methods of correlation of rock formations by means of fossil plants.

613 —— The Cretaceous rim of the Black Hills [South Dakota].

Jour. of Geol., vol. ii, pp. 250–266.

Abstract: Am, Nat., vol. xxviii, pp. 794–795 (⅛ p.).

Describes the occurrence of cycads in Cretaceous strata of the Black Hills and gives the section of the Cretaceous and Jurassic strata, with notes on the fossil plants collected. Discusses the bearing of the facts presented on the Lower Cretaceous of North America.

614 —— Recent discoveries of cycadean trunks in the Potomac formation of Maryland.

Torrey Bot. Club, Bull., vol. xxi, pp. 291–299.

Gives a historical sketch of the discovery of cycadean trunks in the Cretaceous strata of Maryland.

615 **Weed** (Walter Harvey). The formation of hot-spring deposits.

Int. Cong. Geol., Compte Rendu, 5th session, pp. 360–363.

Describes the formation of hot-spring deposits in the Yellowstone National Park.

616 —— Livingston to Snake Plains. Itinerary, Livingston to Bozeman [Mont.].

Int. Cong. Geol., Compte Rendu, 5th session, pp. 364–365.

Describes the geologic structure of this region.

617 —— The Laramie and the overlying Livingston formation in Montana, with report on the flora by F. H. Knowlton.

Abstracts: Am. Jour. Sci., 3d ser., vol. xlvii, pp. 404–405; Am. Geol., vol. xiv, pp. 391–392.

Noticed in Bibliography and Index for 1892 and 1893.

617*a* —— The glaciation of the Yellowstone Valley north of the Park.

Abstract: Am. Geol., vol. xiv, pp. 393–394 (⅛ p.).

Noticed in Bibliography and Index for 1892 and 1893.

617*b* —— and **Iddings** (J. P.). Yellowstone Valley, from Livingston to Cinnabar.

Int. Cong. Geol., Compte Rendu, 5th session, pp. 326–335.

Describes the geology and structure of the region and its glacial phenomena.

617*c* **Weed** (Walter Harvey) and **Iddings** (J. P.). Livingston folio. Montana.

U. S. Geol. Surv., Geologic Atlas of the United States, folio 1.
See Iddings (J. P.) and Weed (W. H.), No. 307.

618 **Weeks** (Joseph D.). The Potomac and Roaring Creek coal fields in West Virginia.

U. S. Geol. Surv., 14th Ann. Rept., pt. 2, pp. 567–590, pls. lxxiii–lxxiv, figs. 73–75.

Describes the location of the coal basins, gives the sections displayed at various points and chemical analyses of the coals.

618*a* **Wells** (H. L.), **Pirsson** (L. V.) and. On the occurrence of leadhillite in Missouri, and its chemical composition.

Am. Jour. Sci., 3d ser., vol. xlviii, pp. 219–226.
See Pirsson (L. V.) and Wells (H. L.), No. 457.

619 **Westgate** (Lewis G.). The mineralogical character of certain New Jersey limestones.

Am. Geol., vol. xiv, pp. 308–313.

Gives a chemical analysis of the limestone and describes the characters of pyroxene and biotite and the microscopic characters of the two special types of the rock, pyroxene rock and quartz rock.

620 —— The age of the crystalline limestones of Warren County, N. J.

Am. Geol., vol. xiv, pp. 369–379, with map.

Describes the petrographic characters of these limestones and their relationship with other crystalline limestones of the State, and reviews the opinions of other writers as to their age. Describes the relations of the limestones with the gneisses and eruptive rocks, and concludes that the limestones of this region are older than the blue magnesian limestone of Cambrian age.

621 **Weston** (T. C.). Notes on the "Quebec group."

Ottawa Nat., vol. viii, pp. 81–82.

Describes an exposure of these beds near Quebec.

622 —— Notes on the Miocene Tertiary rocks of the Cypress Hills, Northwest Territory, Canada.

Nova Scotian Inst. Sci., Proc. and Trans., 2d ser., vol. i, pp. 223–227.

Gives a section of the Miocene beds in this region and notes on the fossils found in them.

623 **Wheeler** (H. A.). The calculation of the fusibility of clays.

Eng. and Mg. Jour., vol. lvii, pp. 224–225 and 244.

Gives in tabular form the chemical analyses and fusibility of clays from different parts of Missouri, and discusses the results obtained.

624 **White** (Charles A.). The relation of biology to geological investigation.

U. S. Nat. Mus., Ann. Rept., 1892, pp. 245–368.

Describes the character and limitations of sedimentary formations and discusses the character, origin, and relation of fossil remains to structural geology, the chronological value of fossils, and the criteria of past aqueous conditions.

624*a* **White** (David). Flora of the outlying Carboniferous basins of southwestern Missouri.

Abstract: Am. Geol., vol. xiii, pp. 283–284 (½ p.).
Noticed in Bibliography and Index for 1892 and 1893.

625 **White** (Israel C.). From Cumberland, Md., to the Ohio River.

Int. Cong. Geol., Compte Rendu, 5th session, pp. 279–288.
Describes the outcrops of the Devonian and Caboniferous rocks and the structure of the Appalachians in this region.

625*a* —— [Past drainage systems of the Upper Ohio basin.]

Abstract: Am. Geol., vol. xiii, p. 219 (⅛ p.).

626 **White** (Theodore Greely). The geology of Essex and Willsboro townships, Essex County, N. Y.

N. Y. Acad. Sci., Trans., vol. xiii, pp. 214–233, pls. vi–vii.
Describes the geology of the region, including strata of Archean, Cambrian, Silurian, and Pleistocene age. Includes a record of dikes and list of fossils collected.

626*a* **Whiteaves** (J. F.). The Cretaceous system of Canada.

Abstracts: Am. Geol.. vol. xiii, p. 193 (9 l.); Am. Nat., vol. xxviii, p. 161 (⅜ p.).
Noticed in Bibliography and Index for 1892 and 1893.

626*b* —— Note on the recent discovery of large unio-like shells in the Coal Measures of South Joggins, Nova Scotia.

Abstracts: Am. Geol., vol. xiii, p. 193 (7 l.); Can. Rec. Sci., vol. vi, pp. 59–60 (½ p.).
Noticed in Bibliography and Index for 1892 and 1893.

627 **Whitfield** (Robert Parr). On new forms of marine algæ from the Trenton limestone, with observations on Buthograptus laxus Hall.

Am. Mus. Nat. Hist., Bull., vol. vi, pp. 351–358, pl. xi.
Considers that certain fossils that have been described as graptolites are true marine algæ. Describes three new genera and species.

628 —— Mollusca and Crustacea of the Miocene formations of New Jersey.

U. S. Geol. Surv., Mon. xxiv, 195 pp., pls. i–xxiv.
Reviews previous descriptions of fossils from these beds. Gives a list of the genera and species found and describes many of them.

629 —— Contributions to the paleontology of Ohio.

Ohio Geol. Surv., vol. vii, pp. 407–494.
Describes fossils from the Paleozoic rocks of Ohio.

629*a* —— Republication of descriptions of Lower Carboniferous Crinoidea from the Hall collection in the American Museum of Natural History, with illustrations of the original type specimens not heretofore figured.

Review: Am. Geol., vol. xiii, p. 124–125.

630 **Whittle** (Charles Livy). The occurrence of Algonkian rocks in Vermont and the evidence for their subdivision.

Jour. of Geol., vol. ii, pp. 396–429.

Describes the topographic and geologic features of the Green Mountains, and the lithologic and structural differences in the different divisions of the Algonkian series.

631 —— The general structure of the main axis of the Green Mountains [Vermont].

Am. Jour. Sci., 3d ser., vol. xlvii, pp. 347–355.

Describes the rocks which underlie the Olenellus horizon in this region, which are referred to the Algonkian, and the orographic disturbances which they have suffered, and discusses the character of the folding of the Green Mountains.

632 **Williams** (E. H., jr.). South Mountain glaciation [Pennsylvania].

Geol. Soc. Am., Bull., vol. v, pp. 13–15.

Describes glacial phenomena of this region which form a fringe of the great terminal moraine in Pennsylvania.

633 —— Extra-morainic drift between the Delaware and the Schuylkill [Pennsylvania].

Geol. Soc. Am., Bull., vol. v., pp. 281–296, pls. 9–11.

Abstract: Am. Geol., vol. xiii, p. 221 (½ p.).

Describes the topographic features, drainage systems, and the glacial deposits and underlying rocks of the region.

634 —— The age of the extra-morainic fringe in eastern Pennsylvania.

Am. Jour. Sci., 3d ser., vol. xlvii, pp. 34–37.

Describes the glacial deposits in the vicinity of Bethlehem, Pa., and concludes that they are of recent formation, and that the Ice age was of short duration.

635 **Williams** (George Huntington). The Appalachian region.

Int. Cong. Geol., Compte Rendu, 5th session, pp. 268–273.

Describes the geologic formations of the Appalachian region, with special reference to the portion crossed by the Rocky Mountain excursion of the International Congress of Geologists.

636 —— Washington, D. C., to Cumberland, Md. Itinerary.

Int. Cong. Geol., Compte Rendu, 5th session, pp. 274–279.

Describes the geologic features along the route traversed by the excursion.

637 —— The distribution of ancient volcanic rocks along the eastern border of North America.

Jour. of Geol., vol. ii, p. 1–31.

Abstracts: Am. Jour. Sci., 3d ser., vol. xlvii, pp. 140–141; Am. Geol., vol. xiii, pp. 212–213 (⅛ p.).

Reviews the opinions of various writers on the nature of ancient volcanic rocks and describes the distribution of the volcanic areas of eastern North America and gives the author's general conclusions.

637*a* **Williams** (George Huntington). Piedmontite from a new locality.

Abstract: Am. Nat., vol. xxviii, pp. 517–518 (⅔ p.).

Noticed in Bibliography and Index for 1892 and 1893.

638 —— and **Clark** (W. B.). Outline of the geology and physical features of Maryland.

Johns Hopkins Univ. Press, Baltimore, Md., 1893.

Abstract: Am. Jour. Sci., 3d ser., vol. xlvii, p. 320 (½ p.).

This is a reprint of chapters relating to physical geography and geology from the work entitled "Maryland and its Resources," prepared by members of the Johns Hopkins University faculty for the World's Columbian Exposition.

638*a* —— **McGee** (W J), **Willis** (B.) and **Darton** (N. H.). Geology of Washington and vicinity.

Int. Cong. Geol., Compte Rendu, 5th session, pp. 219–251.

See McGee (W J), Willis (B.), Darton (N. H.), and Williams (G. H.), No. 385.

639 **Williams** (Henry Slater). On the age of the manganese beds of the Batesville region of Arkansas.

Am. Jour. Sci., 3d ser., vol. xlviii, pp. 325–331.

Reviews the discussion as to the origin and age of these beds by R. A. F. Penrose, and discusses the paleontologic evidence which indicates that the manganese occurs at a distinct horizon between two limestones—the lower one containing Ordovician species which have been found in rocks called Upper Silurian, and the upper limestone carrying an Upper Silurian fauna which has been reported from Lower Silurian horizons.

640 —— [Correlation of clastic rocks.]

Int. Cong. Geol., Compte Rendu, 5th session, pp. 170–171.

Remarks on the importance of considering the relation of organisms to conditions of environment.

641 —— Dual nomenclature in geological classification.

Jour. of Geol., vol. ii, pp. 145–160.

Abstracts: Am. Jour. Sci., 3d ser., vol. xlvii, pp. 143–145; Am. Geol., vol. xiii, pp. 139–140.

Discusses the value of the time scale and formation scale in geologic classification.

641*a* **Willis** (Bailey). Relations of synclines of deposition to ancient shore lines.

Abstract: Am. Geol., vol. xiii, pp. 140–141.

641*b* —— **McGee** (W J), **Williams** (G. H.), and **Darton** (N. H.). Geology of Washington and vicinity.

Int. Cong. Geol., Compte Rendu, 5th session, pp. 219–251.

See McGee (W J), Williams (G. H.), Willis (B.) and Darton (N. H.), No. 385.

642 **Williston** (S. W.). Kansas pterodactyls.

Kans. Univ. Quart., vol. 1, pp. 1–13, pl. 1, and vol. ii, pp. 79–80.

Gives a list of Pteranodon species hitherto named, and describes some of their characters and those of Nyctodactylus.

643 **Williston** (S. W.). Kansas mosasaurs.
Kans. Univ. Quart., vol. ii, pp. 83–84, pl. iii.
Gives a restoration of Clidastes.

644 —— Restoration of Ceratherium fossiger Cope.
Kans. Univ. Quart., vol. ii, pp. 289–290, pl. viii.
Describes the strata in which the remains of the species were found and gives a figure of the restoration.

645 —— On various vertebrate remains from the lowermost Cretaceous of Kansas.
Kans. Univ. Quart., vol. iii, pp. 1–4, pl. i.
Describes the remains of fishes and turtles found in these beds, including one new species, Cimoliosaurus n. sp.

646 —— A new turtle from the Benton Cretaceous.
Kans. Univ. Quart., vol. iii, pp. 5–18, pls. ii–v.
Describes a new genus and species, Desmatochelys lowii, from the Cretaceous of Nebraska.

647 —— Notes on Uintacrinus socialis Grinnell.
Kans. Univ. Quart., vol. iii, pp. 19–20.
Brief note on the discovery of a colony of this crinoid in Cretaceous strata of Kansas.

648 —— Restoration of Platygonus.
Kans. Univ. Quart., vol. iii, pp. 23–39, pls. vii–viii.
Describes the occurrence of the remains found in Pliocene strata of western Kansas and their characteristics.

649 —— and **Case** (E. C.). Kansas mosasaurs.
Kans. Univ. Quart., vol. i, pp. 15–32, pls. ii–vi.
Gives a list of the species found in Kansas, with notes on Clidastes velox and C. westii n. sp.

650 **Winchell** (Horace V.). A bit of iron range history.
Am. Geol., vol. xiii, pp. 164–170.
Reviews some of the literature on the iron mines of the Lake Superior region.

651 —— [The genesis of ore deposits.]
Am. Inst. Mg. Engrs., Trans., vol. xxiii, pp. 591–593.
In discussion of paper on the same subject by F. Posepny.

652 **Winchell** (N. H.). Field observations of N. H. Winchell in 1892.
Minn. Geol. and Nat. Hist. Surv., 21st Ann. Rept., pp. 79–152.
Notes on the structure and stratigraphy of the Mesabi range, on the strata at Republic, Mich., and on the Potsdam sandstone at Potsdam, N. Y. Includes a paper on some problems of the Mesabi iron ore, previously published in the American Geologist.

653 —— A sketch of the geological investigations in Minnesota.
Jour. of Geol., vol. ii, pp. 692–707.
Gives a historical sketch of the work accomplished by the geological surveys of Minnesota.

653*a* **Winchell** (N. H.) and **Schuchert** (C.). Sponges, graptolites, and corals from the Lower Silurian of Minnesota.

Abstract: Am. Geol., vol. xii, p. 331 (⅓ p.).

Noticed in Bibliography and Index for 1892 and 1893.

654 **Winslow** (Arthur). Geological survey in Missouri.

Jour. of Geol., vol. ii, pp. 207–221.

Gives a historical sketch of the geological surveys of Missouri, describes the work undertaken, and gives a list of the publications.

655 —— [The lead and zinc deposits of the Mississippi Valley.]

Am. Inst., Mg. Engrs., Trans., vol. xxii, pp. 634–636.

In discussion of paper by W. P. Jenney on the same subject.

656 —— [Geological distribution of the useful metals in the United States.]

Am. Inst. Mg. Engrs., Trans., vol. xxii, pp. 735–737.

In discussion of paper by S. F. Emmons on the same subject.

657 —— [The genesis of ore deposits.]

Am. Inst. Mg. Engrs., Trans., vol. xxiii, pp. 588–599.

In discussion of paper on the same subject by F. Posepny.

658 **Wolff** (J. E.). The geology of Hoosac Mountain and adjacent territory [Massachusetts].

U. S. Geol. Surv., Mon. xxiii, pp. 35–108, pls. iv–xi, figs. 9–29.

Describes the topography of the region and the petrographic character of the pre-Cambrian gneiss and the Cambrian (Stockbridge) limestone, and discusses the geologic structure and relations of the formations.

659 —— The geological structure in the vicinity of Hibernia, N. J., and its relation to the ore deposits.

N. J. Geol. Surv., Rept., 1893, pp. 359–369.

Abstract: Am. Geol., vol. xiii, pp. 142–143.

Describes the character of the rocks, the geologic structure, and the probable extension of the iron-ore body.

660 **Woodward** (Anthony). Foraminifera found in the Alabama chalk.

Ala. Geol. Surv., Rept., on the geology of the Coastal Plain of Alabama, p. 289 (½ p.).

Gives a list of Foraminifera, identified by the author, occurring in the Alabama chalk.

661 **Woodward** (Henry). [Mammoth remains of Canada and Alaska.]

Geol. Soc. London, Quart. Jour., vol. l, p. 9 (⅛ p.).

In discussion of paper by G. M. Dawson, "Notes on the occurrence of mammoth remains in the Yukon districts of Canada and Alaska."

662 **Woodworth** (J. B.). Post-Glacial eolian action in southern New England.

Am. Jour. Sci., 3d ser., vol. xlviii, pp. 63–71.

Abstract: Am. Geol., vol. xiii, p. 122 (8 l.).

Discusses the evidences of the carving of rock surfaces by drifting sand, and describes localities in New England where such phenomena have been observed, the wear on the pebble, and their lithologic character.

663 **Woodworth** (J. B.). Carboniferous fossils in the Norfolk County basin [Massachusetts].

Am. Jour. Sci., 3d ser., vol. xlviii, pp. 145–148.

Describes the occurrence of vegetable remains in sandy partings of a quartzose conglomerate, and gives the section of the Carboniferous rocks found in this region.

664 —— The relation between baselevelling and organic evolution.

Am. Geol., vol. xiv, pp. 209–235.

Abstract: Jour. of Geol., vol. ii, pp. 753–754.

Reviews the various theories concerning land erosion, discusses the effect of river changes on organisms, and their distribution, and the relation of the development of the Jura-Cretaceous peneplain with the development of the contemporaneous fauna and flora, and gives a general summary of the facts presented.

665 —— On traces of a fauna in the Cambridge slates.

Abstract: Bost. Soc. Nat. Hist., Proc., vol. xxvi, pp. 125–126.

Describes trails occurring in these slates in the Boston basin.

666 —— Some typical eskers of southern New England.

Bost. Soc. Nat. Hist., Proc., vol. xxvi, pp. 197–220.

Abstract: Am. Geol., vol. xiv, p. 396 (½ p.).

Gives a list of publications on the eskers of this region. Describes the characteristics and distribution of these eskers and discusses their origin.

667 **Woolman** (Lewis). Artesian wells and water horizons in southern New Jersey, with economical, geological, and paleontological notes.

N. J. Geol. Surv., Rept., 1893, pp. 389–421.

Gives the section displayed by several artesian wells in New Jersey and Delaware, with lists of fossils found.

668 **Wortman** (J. L.). Osteology of Patriofelia, a Middle Eocene creodont.

Am. Mus. Nat. Hist., Bull., vol. vi, pp. 129–164, pl. i.

Abstract: Am. Nat., vol. xxviii, pp. 1027–1028.

Describes Patriofelia and compares it with Oxyæna, Hyænodon, and with seals. Discusses its probable habits and the classification and species.

669 —— On the affinities of Leptarctus primus of Leidy.

Am. Mus. Nat. Hist., Bull., vol. vi, pp. 229–231.

Describes a new specimen.

669*a* —— and **Earle** (Charles). Ancestors of the tapir.

Abstract: Am. Nat., vol. xxviii, p. 416 (½ p.).

Noticed in Bibliography and Index for 1892 and 1893.

669*b* —— **Osborn** (H. F.) and. Fossil mammals of the Lower Miocene White River beds; collection of 1892.

Am. Mus. Nat. Hist., Bull., vol. vi, pp. 192–228, pls. ii–iii.

See Osborn (H. F.) and Wortman (J. L.), No. 433*b*.

670 **Wright** (Albert A.). On the ventral armor of Dinichthys.
Ohio Geol. Surv., vol. vii, pp. 620–626.
Reviews some of the previous descriptions of the ventral armor of Dinichthys.

671 —— The ventral armor of Dinichthys.
Am. Geol., vol. xiv, pp. 313–320, pl. ix, figs. 1–2.
Describes material collected from the Cleveland shale of Ohio.

672 —— Limits of the glaciated area in New Jersey.
Geol. Soc. Am., Bull., vol. v, pp. 7–13.
Abstract: Am. Geol., vol. xii, p. 166 (⅜ p.).
Describes the character of the glacial material, the topography of the region and its influence on glaciation, the determination of the limits of the glaciated area, and the duration and efficiency of glacial ice.

673 **Wright** (G. Frederick). Continuity of the Glacial period.
Am. Jour. Sci., 3d ser., vol. xlvii, pp. 161–187, figs. 1–7.
Abstracts: Am. Geol., vol. xiii, p. 286 (¼ p.); Am. Nat., vol. xxviii, pp. 508–510.
Discusses the evidences as to whether the erosion of the rocky gorge of the Ohio and its tributaries was pre-Glacial or inter-Glacial, illustrated by four maps. Reviews the evidences of pre-Glacial erosion in the Delaware valley, and gives a summary of the events of the Glacial period.

674. —— The Cincinnati ice dam.
Pop. Sci. Mo., vol. xlv, pp. 184–198.
Discusses the evidence which indicates the former existence of an ice dam in the vicinity of Cincinnati.

674*a* —— [Past drainage systems of the Upper Ohio basin.]
Abstract: Am. Geol., vol. xiii, p. 219 (⅛ p.).

674*b* —— Glacial history of western Pennsylvania.
Abstract: Am. Geol., vol. xiii, pp. 219–220 (⅜ p.).

675 **Wurtz** (Henry). The density of the earth.
Sci. Am. Suppl., vol. xxxvii, p. 15028.
Discusses some of the methods used by certain investigators to ascertain the earth's density.

676 —— Gold genesis.
Sci. Am. Suppl., vol. xxxviii, pp. 15644–15645.
Reviews the theories as to the origin of gold.

Z.

677 **Zittel** (K. von). [Correlation of clastic rocks.]
Int. Cong. Geol., Compte Rendu, 5th session, p. 155 (⅛ p.).
Discusses briefly the relative value of plant and animal remains for purposes of correlation.

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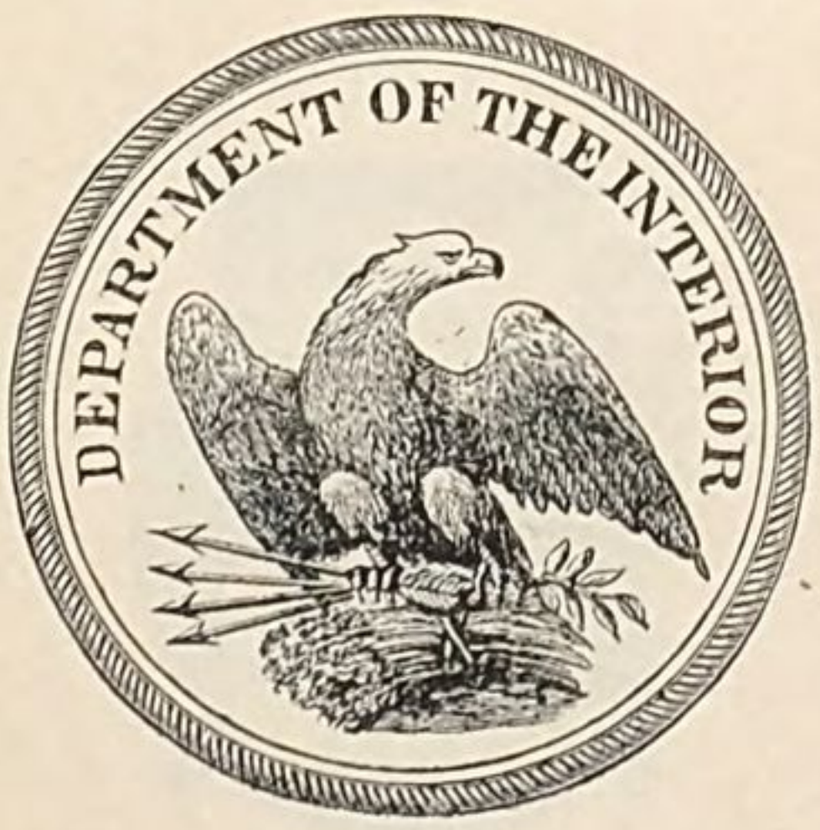
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CHARLES D. WALCOTT, DIRECTOR

THE

ANCIENT VOLCANIC ROCKS

OF

SOUTH MOUNTAIN, PENNSYLVANIA

BY

FLORENCE BASCOM



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LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
Baltimore, Md., March 17, 1894.

SIR: I have the honor of transmitting herewith, for publication as a bulletin of the Survey, a paper by Miss Florence Bascom on the Ancient Volcanic Rocks of South Mountain, Pennsylvania.

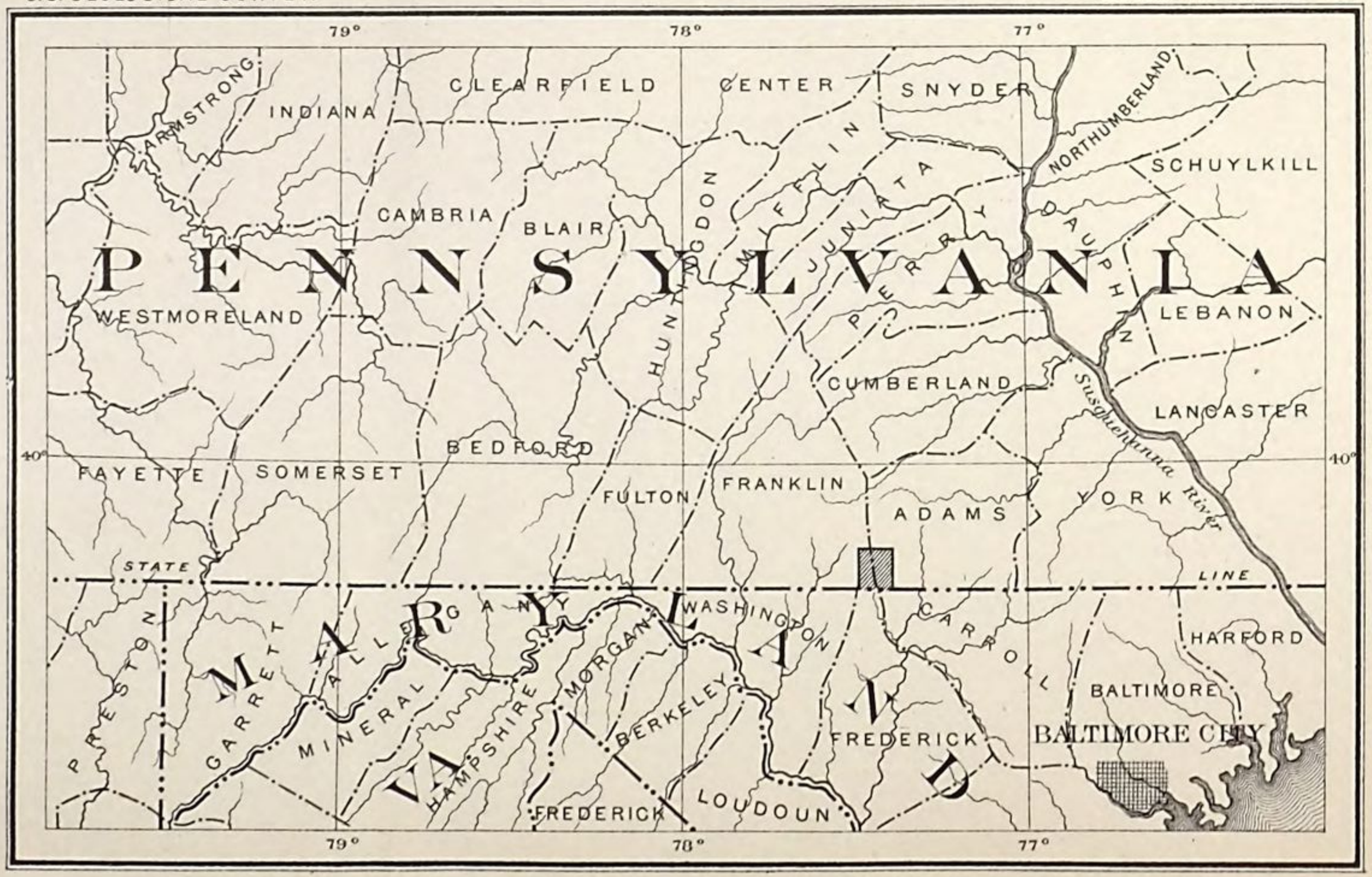
This work was done in the field during the summer of 1892 and in my laboratory during the winter of 1892–93. That part of it relating to the acid eruptive rocks was accepted in June, 1893, as a thesis for the degree of doctor of philosophy at the Johns Hopkins University.

Since that time the paper has been amplified and improved, and I believe that the detailed investigations which it describes will prove to be of permanent value in elucidating the character and history of ancient volcanic rocks, not merely in South Mountain, but in many other regions of the Eastern United States.

Very respectfully,

GEORGE H. WILLIAMS,
Geologist.

Hon. J. W. POWELL,
Director United States Geological Survey.



MAP SHOWING LOCATION OF MONTEREY DISTRICT.

THE ANCIENT VOLCANIC ROCKS OF SOUTH MOUNTAIN, PENNSYLVANIA.

By FLORENCE BASCOM.

INTRODUCTION.

The mountain range known in Vermont as the Green Mountains, in Massachusetts as the Taconic Mountains, and in New York and New Jersey as the Highlands, is the South Mountain in Pennsylvania and Maryland, the Blue Ridge in Virginia, and the Smoky Mountains in North Carolina. The South Mountain in Pennsylvania lies just east of the middle of the State, and stretches from Maryland north and east in a sickle-shaped curve toward the Susquehanna. While in the New England States the mountains of this range rise to heights from 3,000 to 4,000 feet above sea level, and in its southern extension from 4,000 to 7,000 feet, in Pennsylvania its summits rarely exceed 1,500 feet.

South Mountain is 50 miles in length, and 10 miles wide at its broadest point. It covers from 150 to 175 square miles, and abundantly exposes distinct and interesting rock types. These rocks, prevailing throughout the entire South Mountain range, have long been known to geologists, although their true character was not recognized until recently.

In December, 1892, as the result of field work on the part of Dr. G. H. Williams in the northern and of the writer in the southern portion of South Mountain, there appeared a preliminary description[1] of two of the rock types, in which their identification as ancient volcanics was announced. In this bulletin it is proposed to substantiate that identification with more detailed proof. It is further proposed to show that these ancient igneous rocks were, at the time of their consolidation, identical in character with their recent volcanic analogues, and that their present differences are due to subsequent changes, chief among which has been devitrification. It is also proposed to recognize these facts in the nomenclature.

The petrographical features of the third and only remaining rock type of the South Mountain will also be described in some detail.

A brief report upon the previous geological work accomplished in the South Mountain, and some account of the structural features of the mountain and the age of its rocks, will precede the petrographical discussion.

[1]The volcanic rocks of the South Mountain in Pennsylvania and Maryland: Am. Jour. Sci., 3d series, Vol. XLIV, Dec., 1892, pp. 482–496, Pl. I. Reprinted in the Scientific American for Jan. 14, 1893.

CHAPTER I.

AN ACCOUNT OF GEOLOGICAL SURVEYS IN THE SOUTH MOUNTAIN BELOW THE SUSQUEHANNA.

HISTORICAL REVIEW.

The first topographical description of South Mountain appeared as early as 1755.[1] It was made by Lewis Evans, of Philadelphia, who describes the South Mountain with a fair degree of accuracy, as "not in ridges like the Endless Mountains, but in small, broken, steep, stony hills; nor does it run with so much regularity." He continues: "In some places it gradually degenerates to nothing, not to appear again for some miles, and in others it spreads several miles in breadth."

In a publication[2] which appeared in Germany in 1787 several pages are devoted to a general description of South Mountain. Two of the type rocks (the sandstone and the porphyry) were noted and aptly described, as the following quotation shows:

> One finds here and there gray *laminated sandstones with quartz veins;* fragments of coarse ferruginous quartz. At one spot on the road [from Sharpsburg to Fredericktown] I found blocks of *gray-reddish porphyry* with little transparent quartz grains intermixed, and milk-white opaque feldspars. * * * The South Mountain in its entire extent contains rich crevices, gangues, and nests of ore, especially of iron and copper. * * * I have still to add, from the observations made upon this journey, that the eastern slope is gentler and more gradual than the western.

The most important publications on the South Mountain have appeared under the auspices of the various surveys of Pennsylvania and Maryland. The First Geological Survey of Pennsylvania was organized in 1836 under the distinguished geologist, Henry D. Rogers.

The difficulties encountered, however, were so great that it was not until 1858 that the two quarto volumes of the survey were issued. Professor Rogers deals somewhat cursorily with the South Mountain region. He says:[3]

> In its geological constitution, this tract is without much variety, for it contains *scarcely any rocks* except those of the Primal series. It is doubtful if the true gneissic rocks anywhere reach the surface within its borders, and only in one or two localities have even the lowest members of the Auroral limestones been met with covering the upper Primal slates. Even of intrusive igneous rocks, it embraces a *singularly small amount,* those met with being chiefly greenstones and trap rocks.

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[1] Analysis of a Map of the British Colonies in America, 1755.

[2] Schöpf's Beyträge zur mineralogischen Kenntniss des östlichen Theils von Nordamerika und seine Gebürge, chapter 30, pp. 96–101, Erlangen, 1787. A translation of this work has been made by Prof. John M. Clark, of the New York State Museum of Natural History, to whose kindness the writer its indebted for a copy of the unpublished manuscript of the pages relating to South Mountain.

[3] Geology of Pennsylvania, Vol. I, Part II, pp. 203–209, 1858.

The geological structure or mode of stratification of this belt is equally simple. The whole tract consists of two or three groups of high, narrow, nearly parallel anticlinal ridges, expanding and subdividing toward the southwest. These are composed of the Primal white sandstone. Between them are high parallel valleys and plateaus of the *Primal upper slates*, which, from being softer and more fissile, have been worn and trenched by the plowing force of waters to somewhat lower levels than the more resisting, better cemented sandstones. The crests of the ridges are therefore stony and rugged, their flanks usually smoother, being formed chiefly of the *slate*.[1]

That Professor Rogers did not include in the "singularly small amount" of igneous rocks the rocks forming the valleys, the mountain flanks, and even the summits of the mountains, is further indicated by the following:

> Another section across the mountain more to the southwest extends from south to north along the Baltimore and Carlyle turnpike. The first important stratum of the hills is the usual gray *siliceous altered rock*, so common along their southern side.
>
> North of this, about 3 miles from Petersburg, occurs the *dark green slate*, with its epidote and white intrusive quartz. Succeeding this is an extremely *compact siliceous altered slate*, and beyond this a *reddish gray rock*, of the same series, containing specks of reddish feldspar and small veins of epidote, and near this the *fissile talcose rock*, several times mentioned before. * * * The *summit* of the ridge exhibits a dark blue and greenish blue indurated rock, weathering a dark brown, and evidently very ferruginous. It appears to be a band of the Primal slate in a *highly metamorphic* condition, approaching jasper. * * * These lower Primal slates are highly indurated, and even decidedly crystalline, containing in some of their layers *segregated specks*, and *even half-formed geodes* of epidote and other minerals.

On page 206 of the same report Professor Rogers has figured a section across South Mountain, along the Gettysburg Railroad, from Fairfield to Monterey Springs. This section shows stratified rocks lying in a series of anticlinal flexures, which accord rather with Professor Rogers's conception of "rock waves" than with his observed dips. These dips are, with a single exception, to the southeast. Accompanying the section is the following description, which bears directly upon the portion of South Mountain that is particularly discussed in this bulletin:

> Passing now to the eastward of the Green Ridge axis we cross a high slope of slate, apparently the upper Primal, in a synclinal fold, and then traverse a succession of outcrops of the Primal white sandstones and slates to the eastern base of the high land called Jack's Mountain, at the foot of which the older rocks disappear under the Mesozoic red sandstone of the plain of Adams County.
>
> The exposures in the sandstone near the tunnel opposite Jack's Mountain indicate a probable thickness of 1,000 feet. Near the tunnel at the northwest side of the mountain there is a hard epidotic rock, and not far from it a *highly altered greenish slate*, a rock found in several other localities farther west and containing layers of *gray slate, spotted with epidote*. Farther west occurs epidote with asbestus. Near Minie Branch search was made many years ago for copper ore, but nothing was found to justify the expectation of finding a productive vein of that mineral. A small quantity of copper ore was once obtained and a furnace built for smelting it in a small ridge north of Jack's Mountain, but the exploration was abandoned. The metal occurs in the form of a green and blue carbonate, with a little native copper. Evidently the ore is not abundant.

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[1] The italics in this and the following quotations are the writer's.

Many of the characteristic features of the South Mountain rocks were aptly described by Professor Rogers, yet, plainly, their nature was not fully understood nor their importance appreciated at the close of the First Geological Survey of Pennsylvania. In 1860 the Primal series of Pennsylvania, as it occurs in Maryland, was thus characterized by Tyson:[1]

1. A hard sandstone, made up of grains of quartz, with occasionally grains of feldspar and kaolin.

2. A slate, varying in color from gray to brownish and greenish. It is ranked as an argillite, but portions of it assume a marked talcose appearance, especially in the Catoctin Mountain, and in parts of Middletown Valley, where it has been much disturbed and altered by proximity to intrusive rocks. These last consist of amphibolites (trap), porphyries, amygdaloid, serpentine, and epidote. This last-named rock is extensively developed, both in large masses and intercalated between the slates.

The Second Geological Survey of Pennsylvania was organized in 1874 under Prof. J. P. Lesley, who had been an assistant to Professor Rogers in the earlier survey.

With improved facilities for scientific work, and with more accurate methods of mapping, a new survey of South Mountain was undertaken by Dr. Persifor Frazer, with A. E. Lehman as topographical assistant. Five sections (Nos. 7, 8, 9, 10, 11), more or less incomplete, were made through the mountain, and as the result of his investigations Dr. Frazer says:[2]

It is apparent that the great South Mountain is composed essentially of two groups of rocks, the *lower* (and along this line, the northwestern) consisting of various modifications of the quartz conglomerate above spoken of, and in which quartz occurs in various forms.

The *upper* and southeasterly group is felsitic in character, but contains, also, large beds of hydromica and chlorite schists intersected by veins of milk quartz, while the orthofelsite presents every variety of appearance, from a sandy and earthy slate, in which the crystals of orthoclase are very much decomposed, indeed, are sometimes almost clay, through the jasper-like variety to the massive and coarsely porphyritic structure in which it is suited to be used as an ornamental building stone.

In the same year (1877) Dr. Frazer published a further account[3] of the nature and origin of these "orthofelsites." This account was in substance twice repeated by him, in 1879[4] and in 1880:[5]

The rocks of this region [South Mountain] may be divided into two great series—a western (*underlying*), of which the characteristic strata are composed of quartzite and of arenaceous schist containing quartz pebbles (Mountain Creek rock), and the eastern (*overlying*) of hydromica and chlorite schists, and orthofelsite, both porphyritic and unporphyritic. Both these series show indications of having been penetrated by dikes of plutonic character within this area.

The porphyry, which carries the copper in this region, *shows no character of igneous action, but occurs in coarse and thin beds*, more or less disintegrated, and in certain

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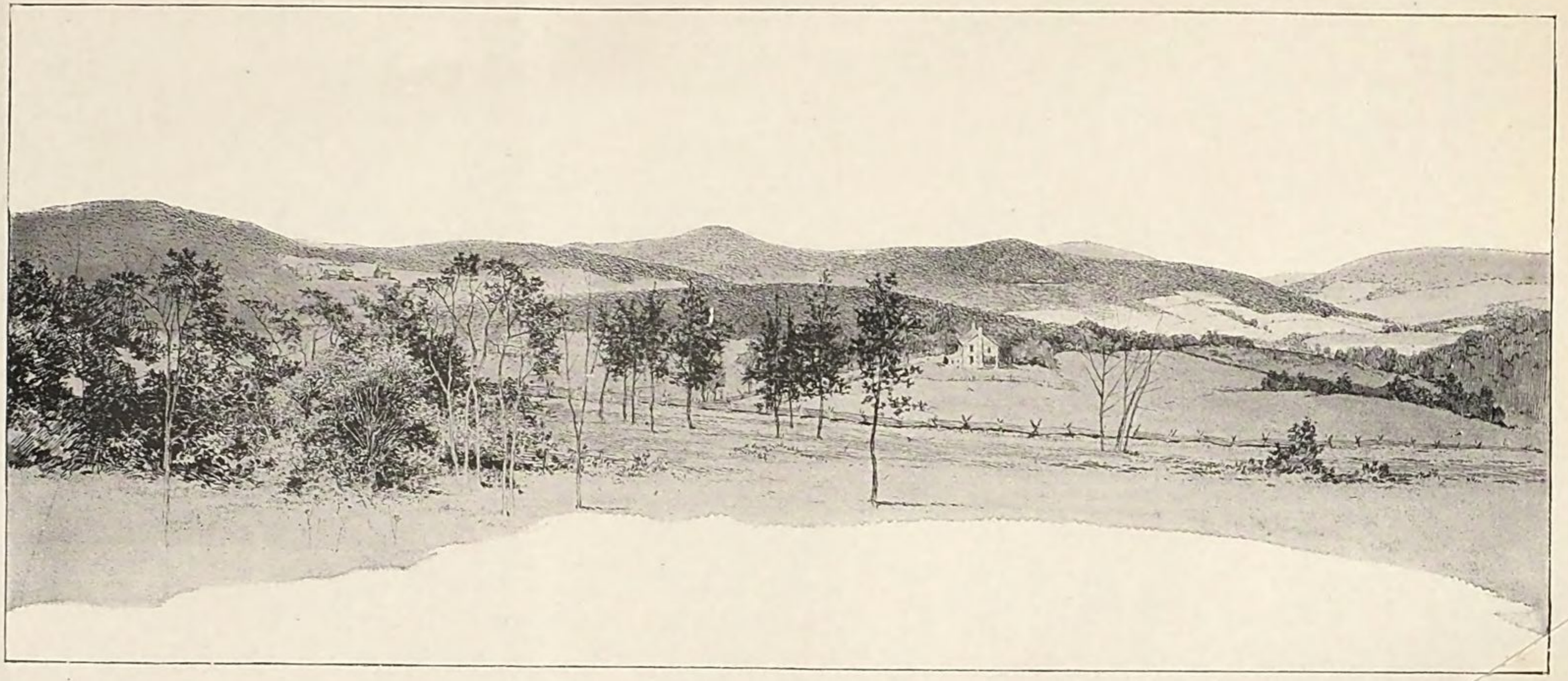
[1]Report on the Geology of Maryland, Jan., 1860, pp. 34, 35.

[2]Report of Progress in the Counties of York, Adams, Cumberland, and Franklin, 1877, CC, pp. 285–295.

[3]The copper ores of Pennsylvania: Polytechnic Review, Nos. 16 and 17, Vol. III, April, 1877.

[4]Trans. Am. Inst. Min. Eng., Vol. VII, 1879, p. 338.

[5]Second Geol. Survey, Pa., CCC, Appendix, 1880, pp. 312–313.



PANORAMIC VIEW OF THE MOUNTAINS OF THE MONTEREY DISTRICT.

localities reduced almost to the state of kaolin. Nothing which might correspond to the term sandstone was observed, though all the above sediments were free of grit and sandy particles. * * * It seems fair to conclude that the region of the copper-bearing rocks belongs to the Huronian cycle.

With these views Dr. T. Sterry Hunt expressed entire concurrence.[1]

Dr. Hunt had previously made some study of the South Mountain rocks, and published, at various times, his observations concerning them. In 1876 he said:[2]

In the southern part of Pennsylvania, to the west of Gettysburg, this mountainous belt, rising between the Mesozoic on the east and the great limestone valley on the west, presents an immense development of a peculiar type of crystalline rocks which I detected there last year, and which has a considerable geological importance. It is a *bedded* petrosilex, grayish, reddish, or purplish in color, sometimes granular but more often jasper-like in texture, and frequently porphyritic from the presence of small crystals of orthoclase-feldspar or of glassy quartz. There is found here a great breadth of this rock distinctly bedded, presenting different varieties, and alternating with dioritic, or diabasic, epidotic, and chloritic rocks, with argillites, in which are sometimes included thin beds of the petrosilex, the strata generally dipping at high angles to the east.

These rocks Dr. Hunt provisionally referred to a position near the base of the Huronian division, adding:

This petrosilex is identical in its lithological character with the hälleflinta, or stratified flint rock of the Swedish geologists, which is by them assigned a similar position, i. e., above the most ancient gneisses.

In 1878 Dr. Hunt expressed essentially the same views,[3] and in 1879[4] he opposed the correlation of the South Mountain rocks with the copper-bearing rocks of Lake Superior (Keweenawan series), although at an earlier date he notes a resemblance. He says:[5]

I may also note that I have observed bedded petrosilex rocks like those just noticed [South Mountain porphyries] to the north of Lake Superior, both in an island south of St. Ignace and on the adjacent mainland. The conglomerates or breccias, which, in the rocks of the Keweenawan series on the south shore of the lake, include the native copper of the Calumet and Hecla and the Boston and Albany mines, are also made up of the ruins of a precisely similar petrosilex porphyry.

In October, 1879, Mr. J. F. Blandy made a brief reconnoissance of the lower portion of the South Mountain with not unfruitful results. He makes a suggestive correlation of the copper-bearing rocks of southern Pennsylvania with the Lake Superior copper formation,[6] thus recognizing the volcanic nature of the greenstones, at least, which he called "amygdaloidal trap." The acid rocks still remain "slates."

In the final report of the Pennsylvania survey,[7] Professor Lesley

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[1] Trans. Am. Inst. Min. Eng., Vol. VII, 1879, p. 339.
[2] Proc. Am. Ass. Adv. Sci., 1876, pp. 211-212.
[3] Second Geol. Surv. Pa., Vol. E, p. 193.
[4] Trans. Am. Inst. Min. Eng., Vol. VII, p. 331.
[5] Proc. Am. Ass. Adv. Sci., 1876, p. 211.
[6] Trans. Am. Inst. Min. Eng., Vol. VII, pp. 331-333.
[7] Final Report of the Pa. Geol. Surv., Lesley, Summary, Vol. I, 1892.

gives in substance the views of Dr. Frazer, which have already been quoted. He refers to Dr. Frazer's "section 8" as representative of the South Mountain rocks and structure. In this section, as in the others in which the orthofelsite appears, notably section 9, the bedded orthofelsite is represented as overlying the quartzose conglomerate. Professor Frazer concludes his summary with the statement that "it is hard to avoid the inference that our South Mountain rocks represent the Huronian section of Murray and Logan."

The geological map of Adams, Cumberland, and Franklin counties made by this final Pennsylvania survey refers all the rocks of the South Mountain region by the use of a single color to the "Azoic system."

The Second Geological Survey of Pennsylvania, while recognizing the extent and crystalline character of the South Mountain rocks and emphasizing the absence of the Primal of Rogers, still failed to solve the problems of the structure of the region and the age and origin of its rocks.

Professor Lesley has been very ready to acknowledge the incompleteness of the survey in the South Mountain, and since Mr. Walcott's determination of the age of its sedimentary rocks has appeared, he has expressed himself as desiring a new investigation of that region. While he claims that the survey of Pennsylvania "has been so minute and complete that comparatively little remains to be desired in the future," he adds: "The geology of the South Mountain is therefore [because of the new aspect given to it by the investigation of Mr. Walcott] in a very unsatisfactory condition and requires, in fact, a special and protracted investigation in the field. It is the most unsatisfactory part of the work of the Geological Survey of the State."[1]

Subsequent workers in the South Mountain are indebted to the Survey for the superior topographical maps of the mountain made on a scale of 1 inch to 1,600 feet (about 3 inches to the mile) by A. E. Lehman. These maps are invaluable to the field geologist and render possible accurate areal mapping. Owing to a confusion of cleavage planes and bedding the dips recorded on these maps are not reliable.

While the geological explorations of the South Mountain have been careful and minute and conducted by able geologists, the petrography of its rocks has never been thoroughly investigated. The microscope has not been used to assist in determining the nature and origin of the rocks, and to correct impressions colored by preconceived ideas or by an experience more or less limited to sedimentary structures. Under microscopic scrutiny and the comparative study of recent lavas, an increasing number of the so-called sedimentary rocks are proving to be igneous in origin. That such has proved to be the case in the South Mountain, while not surprising, is a fact of considerable significance, both because of characteristics which the rocks themselves possess and

[1] Report of the Board of Comm., pp. 5-6, 1893.

because they form an important part of a belt of similar rocks extending northward and southward along the Atlantic Coast.

Following is a list of publications on the rocks of South Mountain, Pennsylvania:

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CHAPTER II.

GEOLOGICAL RELATIONSHIP OF THE ROCKS OF THE MONTEREY DISTRICT.

GENERAL DESCRIPTION OF THE AREA STUDIED.

This bulletin will treat chiefly of the geology of that portion of South Mountain which lies in Franklin and Adams counties and is embraced between the lower Cambrian quartzites of the Green Ridge on the west and the Triassic red sandstones of the plains on the east. The southern limit is the State line, while a parallel line passing through the Russel copper mine, some 6 miles to the north, furnishes a northern boundary.[1] (See Pl. I.) Well-wooded mountains (Green Ridge, Monterey Peak, Pine Mountain, Jacks Mountain, Raven Rock Mountain, Haycock Mountain, etc.), varying in altitude from 1,500 or 1,850 feet, with a general trend from northeast to southwest, inclosing high plateau-like valleys and sloping toward the eastern plains, constitute a region of exceptional natural beauty and geological interest. (See Pl. II.)

Though but a limited portion of an extended South Mountain area, this district is in many respects quite typical and furnishes ample material for some general conclusions in regard to the geology of the entire area. Although, because of the short time at the disposal of the writer, detailed field work was limited to the Monterey district, the petrographical study included material collected throughout the South Mountain.

EXTENT AND CHARACTER OF THE THREE ROCK TYPES.

Three distinct rock types are readily recognized. (Pl. III.)

1. A siliceous sedimentary rock, represented by a quartzose conglomerate, a sandstone, and a quartzite. This is rarely accompanied by an interbedded argillaceous slate.

2. An acid volcanic rock, which shows all phases of crystallization, from a spherulitic rhyolite to a true quartz-porphyry, is amygdaloidal or compact, is accompanied by pyroclastics and breccias, and is sometimes sheared into a perfectly fissile slate or sericite-schist.

3. A basic, holocrystalline, volcanic rock, which is usually amygdaloidal, massive, or more frequently schistose, and is also accompanied by pyroclastics and breccias and sheared to a slate.

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[1] As a matter of convenience this area will be called the Monterey district.



JULIUS BIEN & CO. LITH. N.Y.

GEOLOGIC AND TOPOGRAPHIC MAP OF THE MONTEREY DISTRICT.

Scale

0 ¼ ½ 1 2 MILES.

The slates of the region thus prove to be both sedimentary and igneous. The former are argillaceous. The latter are either acid or basic, and are far more abundant than the former.

SEDIMENTARY ROCKS.

Areal distribution.—The first-mentioned of the rock types occupies the high altitudes only, Green Ridge, Monterey Peak, Pine Mountain, and Jacks Mountain being largely formed of it, while it caps Haycock Mountain and the foothill to the east of Jacks Mountain.

Structural features.—The strike of the sediments is uniformly northwest and southeast, with a mean dip of about 45 degrees southeast. There are some exceptions to this southeasterly dip, notably at Monterey Peak, where the dip is northwest, forming, with the Green Ridge sandstone, a gentle syncline. (See Pl. V.)

In the Jacks Mountain quartzite the bedding is exceedingly obscure and the cleavage very marked. There is an opportunity for error in determining the dip by the confusion of the two.

At the northeast end of the tunnel which is cut through a spur of Jacks Mountain, on the Gettysburg Railroad, stratification is distinctly visible, and shows that minor crumpling of the sediments as well as folding on a large scale resulted from their uplift. The rock is here folded in a series of small anticlines and synclines. (See Pl. IV.)

Thickness.—Professor Rogers estimated the thickness of the sandstone at 1,000 feet. Professor Lesley, on the other hand, considers it "immensely thick," and states that Frazer's "section 11" shows 32,000 feet of quartzite and 64,000 feet of schistose conglomerate.[1]

Walcott[2] and Keith,[3] in their examination of a section of the same quartzite, sandstone, and conglomerate, displayed to the west of the Monterey district, agree essentially with Professor Rogers's estimate (1,000–1,200 feet). The writer did not find sufficient data within the Monterey district for a reasonably correct estimate of the thickness of the quartzite. There are undoubtedly a very great number of minor crumplings and foldings resulting in compressed synclines, anticlines, and thrust planes in Jacks Mountain. Since there are no means of determining the number of these folds, no estimate can be made of the thickness of the formation. If the minor folds are ignored, the dip and horizontal extent of the sediments indicate a thickness which is enormous, an indication unsustained by sections only 2 miles to the west. Probably the estimate made by Mr. Walcott (1,200 feet) in that more favorable locality will be approximately correct for the Jacks Mountain quartzite.

Age and superposition.—These siliceous clastics are the "Primal white

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[1] Summary, Final Report Geol. Pa., Vol. I, 1892, pp. 145–146.

[2] Walcott, Notes on the Cambrian rocks of Pennsylvania and Maryland from the Susquehanna to the Potomac: Am. Jour. Sci., Vol. XLIV, Dec., 1892, p. 481.

[3] Keith, The geologic structure of the Blue Ridge in Maryland and Virginia: Am. Geologist, Dec., 1892, Vol. X, No. 6, p. 365.

sandstone" of Rogers, and are represented by him as interbedded with slates and occurring in a series of narrow anticlines. They form the "Mountain Creek rock" of Frazer and Lesley, mapped by them as Azoic and represented both in sections and text as underlying the "chlorite schists" and "bedded orthofelsites." Messrs. Geiger and Keith,[1] in their earlier investigation of the southward extension of this sandstone in the Blue Ridge, placed it above the limestone of the Cumberland Valley, and, upon structural grounds, determined its age as Upper Silurian (Medina). The true age of these sediments has recently been determined beyond question, through the discovery of fossils, by Mr. Walcott.[2] No fossils were found in the quartzose conglomerates and quartzites of the Monterey district (No. 2 of Mr. Walcott's section), but the interbedded argillaceous shales, of which mention has been made, are found to the west of the Monterey district passing beneath quartzite and other shales in which were discovered the remains of *Scolithus linearis*, *Olenellus*, and *Camerella minor*. These discoveries undoubtedly refer the conformably underlying Monterey quartzite to a Lower Cambrian age.

In a recent section made in the light of Mr. Walcott's discoveries and of his own subsequent discovery of fossils in the Blue Ridge, Mr. Keith[3] gives the Monterey sediments a similar position (No. 4), describing them as a "massive white sandstone with bluish black bands, feldspathic, and in places conglomeratic." Mr. Walcott calls them "a coarse-grained quartzite, sometimes conglomeratic."

The sections (Pl. V) through the Monterey district show the relative distribution and position of the three type rocks. It will be observed that the sandstone lies in a gentle syncline, or almost flat, and wholly above the eruptives. These observations made by the writer in the Monterey district and elsewhere in the South Mountain, accord with the observations of Mr. Keith[4] in Maryland. Owing to the entire absence of exposure, save at the tunnel, the minor folding, which is undoubtedly present at many other points, is not indicated in the sections.

Mr. Keith[5] finds that in Maryland, as a result of faulting, the igneous rocks occasionally overlie the sandstone. This is nowhere the case in the Monterey district. The facts that no inclusions of sandstone were found in the volcanic breccia, and that fragments of the acid eruptive occur in the quartzose conglomerate, suggest the superficial character of the latter.

Further indications of the same nature will be discussed in considering the comparative age of the sedimentary and igneous rocks.

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[1] H. R. Geiger and Arthur Keith, The structure of the Blue Ridge near Harpers Ferry: Bull. Geol. Soc. Am., Vol. II, p. 163, pls. 4 and 5.

[2] C. D. Walcott, Notes on Cambrian rocks of Pennsylvania and Maryland: Am. Jour. Sci., Vol. XLIV, 1892, p. 481.

[3] A. Keith, Geologic structure of Blue Ridge in Maryland and Virginia: Am. Geologist, Vol. X, 1892, p. 365.

[4] Geiger and Keith, loc. cit., p. 155, pls. 4 and 5.

[5] Loc. cit., p. 365.



CRUMPLING OF SANDSTONE AT THE EAST END OF TUNNEL THROUGH JACKS MOUNTAIN, ON THE GETTYSBURG RAILROAD.

ACID ERUPTIVES.

Areal distribution.—The flanks of the mountains, the hills, and the valleys are all formed of volcanic material ("Primal upper slate"), which, as Professor Rogers suggests, furnishes less resistance to erosion than the hard sandstone. Of these rocks the acid lavas are much less abundant and tend to occupy the lower altitudes in this portion of the South Mountain. Farther north the reverse is true.

With the exception of a large district northwest of Jacks Mountain, the acid rocks occur in insignificant areas, such as might be exposed by the erosion of the surrounding greenstone. There are nineteen such limited and isolated occurrences.

Character.—The acid volcanics are always readily distinguished from the basic rocks by their bright colors, which range from a brick-red, through pink, purple, blue, or blue-gray, to a grayish-green, light-green, or buff. Opaque white or red phenocrysts may be conspicuous or almost absent. Bands of spherulites, simulating bedding lines, are a prominent feature, while spherutaxites composed of spherulites ranging in size from a pea to a butternut are by no means uncommon. Eutaxites with a marked yet delicate flow structure are abundant.

Only faint suggestions of the lithophysal structure were found in the Monterey district. To the northwest, at Raccoon Creek, it was found in great perfection.

An amygdaloidal character is less general than with the basic rocks. In a few localities, however, notably the Bigham copper mine region, it is very pronounced. Both flow breccias and tuff breccias occur. The rocks split readily into slabs, and in general are cleaved parallel to the structure planes of the sedimentary rocks. In some instances the porphyries have been sheared into spotted slates, still preserving the crystalline outlines of the feldspar phenocrysts, or into fissile sericite-schists. Such metamorphism is displayed in an exposure of a few feet, or even in a single hand specimen.

There are not sufficient data for an estimate of the thickness of these rocks. In the porphyry area north of the Clermont House, Monterey Springs, several borings have been made for water. One well was bored to the depth of 66 feet in 1878, and carried 48 feet lower in 1886, when it was reported that a "soft rock" was reached. A few rods west of this other attempts were made, in 1892, to bore through the porphyry. The greatest depth reached was 62 feet, when, the character of the rock not altering, the undertaking was abandoned because of the refractory nature of the porphyry.

Previous descriptions.—These are the rocks characterized by Professor Rogers as "a gray siliceous altered rock," "a reddish gray rock of the same series" (Primal upper slate), "a highly metamorphic Primal slate." They are the "orthofelsites" of Frazer, "showing no character of igneous action," and the "bedded petrosilex" of Hunt. Blandy covers them by the term "slates."

Economic value.—The susceptibility of these porphyries to a fine polish and their suitability for ornamental purposes have been remarked by many of those who have studied them.

The earliest mention of this sort was made in 1822 by Dr. Hayden,[1] who notes "handsome porphyry, Nicholson's Gap, Blue Ridge, Pennsylvania, crystals red and distinct."

Speaking of Catoctin Mountain, the southern extremity of South Mountain in Maryland, Tyson says:[2]

> Its porphyries and amygdaloids are deserving of the attention that I propose hereafter to bestow upon them. Some of them will receive a beautiful polish, but their hardness renders the process expensive. This can, however, be overcome by appropriate machinery.

Dr. Frazer[3] has, as already quoted, described the porphyries as "suitable for an ornamental building stone."

Dr. Hunt[4] has also called attention to the fact that "these peculiar rocks, which make such a conspicuous figure in the South Mountain of Pennsylvania south of the Susquehanna, are of interest economically from the fact that they are in other regions the repositories of rich iron ores, and also because they afford ornamental porphyries of rare beauty, similar to those wrought in Elfdalen, in Sweden."

The Tenth Census[5] reports that "it [the South Mountain porphyry] is well adapted to ornamental work, as it is rich in color, durable, and susceptible of a good polish, and in many cases could be obtained in abundant quantities. It has not yet been quarried for purposes of construction."

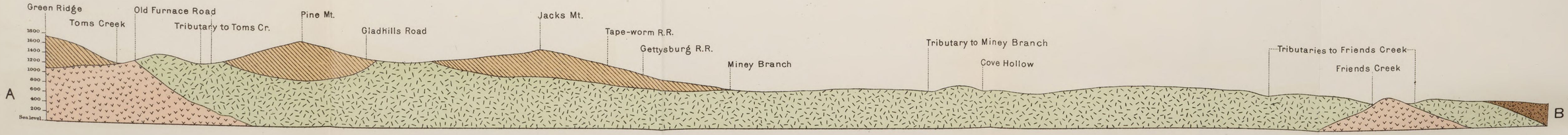
BASIC ERUPTIVES.

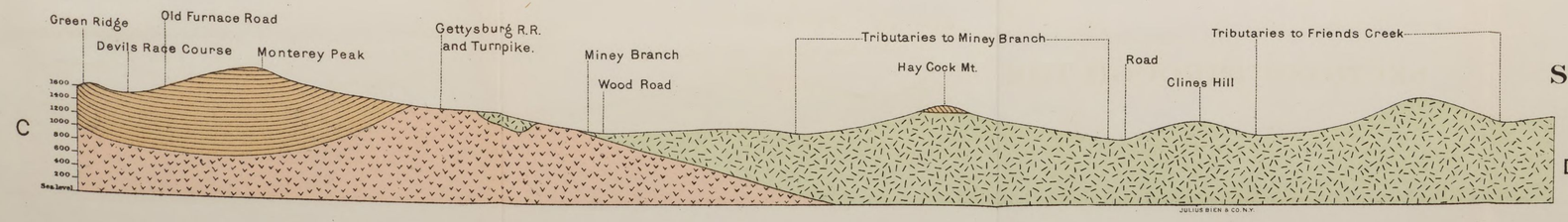
Areal distribution.—The basic eruptives occupy, in this district, an area fully twice as large as that covered by the acid eruptives constituting the major part of the valleys, foothills, and mountain flanks.

Character.—The rocks are massive, schistose, or slaty. They are usually conspicuously amygdaloidal, and associated with these amygdaloids are banded fine-grained schists, which have been considered altered accumulations of volcanic ash. In a section exposed on the Gettysburg Railroad there are alternating bands, from 2 to 3 feet wide, of a compact, fine-grained, epidotic rock which may also represent a basic volcanic ash. Bombs were found embedded in this epidotic rock. As with the acid rocks, there are accompanying basic breccias, though the latter are not abundant. The cementing material in every case was epidotic. An agglomerate formed of rounded fragments from an inch to 6 inches in diameter was also found. There was no opportunity for estimating the thickness of the accumulated basic flows. Wells have been bored in the basic rock to the depths of 55, 85, and 110 feet.

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[1] H. H. Hayden, Mineralogical notes: Am. Jour. Sci. and Arts, Vol. V. 1822, p. 255.
[2] Tyson, First Annual Report, 1860, Appendix, p. 3.
[3] Frazer, Vol. CC, p. 285.
[4] Hunt, Proc. Am. Ass. Adv. Sci., 1876, p. 212.
[5] Tenth Census Report on the Building Stones of the United States, p. 168.





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SECTIONS THROUGH THE MONTEREY DISTRICT.

Cambrian Sandstone.

Triassic Formation.

Volcanics (Pre-Cambrian.)

Basic Volcanics (Pre-Cambrian.)

The basic rock, by reason of its softer character, is more subject to alteration under dynamic action than are the hard acid rocks. The effect of this is seen in the almost universal schistosity of the basic rock. This metamorphism is accompanied by a correspondingly greater chemical alteration than is shown by the acid rocks. The alteration consists largely in the abundant development of epidote and chlorite, which gives to the rock its uniform green color and its popular name of "greenstone."

Previous descriptions.—Dr. Hayden[1] notes the remarkable development of epidote as follows:

> Most beautiful epidote, with green and other shades of copper scattered in quartz. The blue is prevalent. Abundant in Blue Ridge. * * *
>
> Quartz and epidote, with green carbonate and red oxid of copper and native copper. Blue Ridge; abundant.

The greenstones are locally known as the "copper rock," because of the copper ore which they carry. They are Rogers's "lower Primal slates," which "are highly indurated, and even decidedly crystalline, containing in some of their layers segregated specks, and even half-formed geodes [amygdules] of epidote and other minerals." "A highly altered, greenish slate." "Dark-green slate, with its epidote and white, intrusive quartz." Tyson describes them as "slates." Dr. Frazer calls them "chlorite schists," and Dr. Hunt terms them epidotic or chloritic rocks. Blandy approaches most nearly the present idea of their nature in describing them as "amygdaloidal trap."

ORE DEPOSITS OF THE MONTEREY DISTRICT.

The workable deposits of ore in the South Mountain fall into two classes: The limonite ores, which are deposited in Paleozoic sedimentary rocks, and the copper ores, which are associated with pre-Paleozoic igneous rocks.

Profitable limonite iron mines are being worked at various localities in the South Mountain, in the Cambrian sandstone, and along the contacts between it and the Silurian limestone. They are fully discussed in the Final Report of the Second Geological Survey of Pennsylvania, Vol. I.

One such ore bank occurs within the Monterey district, on its northeastern boundary, at the contact between Triassic limestone and the Cambrian sandstone, near Old Maria furnace. This bank is exhausted and has not been worked for many years.

An interesting occurrence of copper ore and native copper[2] is to be found within the South Mountain chain, in a belt extending from a point some 6 miles north of the State line, in a southwesterly direction,

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[1] Loc. cit., 1822, p. 255.

[2] Frazer, Copper ores of Pennsylvania: Polytechnic Review, Vol. III, 1887, No. 16, p. 159; An hypothesis of the structure of the copper belt of the South Mountain, pp. 82–85. Henderson, The copper deposits of the South Mountain: Trans. Am. Inst. Min., Eng., Vol XII, pp. 85–90.

to and beyond the State line into Maryland. This belt lies along the contact between the acid and basic eruptives.[1]

The principal localities where shafts have been sunk within this belt are the Snively copper mines, the Russel farm (the Bechtel shaft), the Reed copper pits, the Bigham copper mine, and the Headlight mine. (See map, Pl. III.) To the east of this belt, on the road between Fairfield and Fountaindale, a fifth old copper shaft is located.

The Snively copper mine, which is a mile north of the Monterey district, was not visited by the writer.

Frazer reports that the copper is associated with quartz, epidotic rock, and azurite.[2]

At the Russel copper mine, which is located on the Russel farm, at the fork of Copper Run, native copper occurs in quartz veins, associated with calcite, in a very siliceous epidotic rock, an epidosite. The material thrown out at the lower shaft was amygdaloidal greenstone; at the upper or Bechtel shaft, an acid slate, which indicates that the copper belt is along the contact between the two igneous rocks.

The Reed copper pits lie on the north side of Toms Creek, at the forking of the highroad near Spring Run. It has not been worked for forty years, and there is nothing visible to indicate the character of the copper occurrence. The dump pile shows scoriaceous greenstones with malachite stains. Dr. Snively reports that native copper occurs here in quartz veins.

The excavation for copper ore on the Bigham property, which lies just northwest of the forking of Gladhills road, furnishes interesting material for the petrographer. It is here that acid amygdaloids have been exposed in great perfection. They are abundantly stained with malachite, azurite, or cuprite. Metallic copper occurs in quartz veins traversing the amygdaloids, and in submacroscopic quantities in the amygdules. In the latter case the copper is frequently surrounded by zones of the oxide and the carbonate. An analysis of these rocks gives 4 per cent of copper. The Headlight mine is tunneled beneath the turnpike half a mile (eastward) below the Clermont House. Here the dump pile shows only greenstones, more or less stained with copper carbonates. This is also the case at the old copper shaft on the Fairfield road. Asbestos in quartz is quite generally found at these copper mines.

Throughout this belt the copper is evidently of secondary origin, occurring in seams and amygdules, where it has been deposited from solution. This occurrence of metallic copper in the igneous rocks of South Mountain is interesting because of its similarity to the Lake Superior copper-ore deposits. Its associations are quite analogous. In the Lake Superior region it occurs in veins, quartzose and epidotic, in the open-textured amygdaloids (basic), and in interbedded con-

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[1] Frazer says: "The ore belt lies in the orthofelsite which forms this portion of the chain."

[2] P. Frazer, Copper ores of Pennsylvania: Polytechnic Review, Vol. III, 1877, No. 16, p. 170; also, Appendix, Vol. CCC, Second Geol. Surv. Pa., p. 310.

glomerates. In the South Mountain, in the absence of contemporaneous interbedded clastics, the occurrence is limited to the igneous rocks.

The replacement of the feldspar by chlorite and epidote, and their replacement in turn by copper, characterizes the amygdaloids of the South Mountain also.

The explanation of the precipitation of the copper is doubtless the same in both regions.[1]

A correlation of the South Mountain formations and the Keweenawan copper-bearing rocks was suggested by Mr. Blandy in the article before quoted. There is great petrographical similarity between the porphyrites and felsites and diabase porphyrites of the Keweenawan series and their equivalents in the South Mountain, but it seems to the writer unwise to parallelize on petrographical evidence the South Mountain igneous rocks and the Keweenawan of Lake Superior. All correlation upon such grounds, when applied to rocks widely separated, is well known to be untrustworthy. There has not as yet been found sufficient evidence to show to what horizon in the Algonkian series the igneous rocks of South Mountain should be referred.

COMPARATIVE AGE OF SEDIMENTARY AND IGNEOUS ROCKS.

CONTACTS DESCRIBED.

That the Cambrian rocks do not underlie the "slates" and "orthofelsites," as stated in the reports of the Pennsylvania surveys, is quite plain, but whether the sediments are entirely subsequent to the igneous rocks or are in part, at least, contemporaneous, it is not so easy to decide.

Contacts between the sedimentary and igneous rocks are finely exposed at two localities. About halfway through the tunnel on the Gettysburg Railroad the basic igneous rocks and the Cambrian rocks are in contact. Both formations dip gently to the southeast ($\pm 20°$). The sandstone has become an indurated quartzite. Close to the greenstone it has acquired a green color, due to the abundant development of chlorite. It has also become very schistose, and in fact might readily be confused with the greenstone itself. Granulation, undulatory extinction, and the obliteration of all direct evidence of clastic origin, as revealed by the microscope, indicate the action of dynamic force on the quartzite. The greenstone is slaty and too decayed at the contact for microscopic study.

Southwest of Old Maria Furnace, in an abandoned cut on the Tapeworm Railroad, a great surface of red felsite[2] is partially exposed and partially overlain by the clastic formation. (Pl. VI.) Here again there is a gentle dip of both rocks to the southeast ($\pm 45°$). The sand-

[1] Pumpelly, Geology of Michigan, Vol. I, Part III, p. 43.

[2] Felsite is used here as a field term for a compact, stony, nonporphyritic or inconspicuously porphyritic volcanic rock. See pp. 37–38.

stone has become a vitreous quartzite. The hard felsite does not show alteration. That the igneous and sedimentary rocks have been subjected to the same forces of folding is shown by the uniformity of their cleavage dips at both these localities.

This conformity of structure planes, the absence of contact metamorphism, and the evidences of dynamic action indicate planes of thrust rather than planes of original deposition or of subsequent igneous intrusion.

CONCLUSIONS.

These two contacts do not decisively prove the younger age of the overlying sediments, although they very strongly indicate it. If the sandstone has been thrust over the lava from *beneath*, it would be necessary to suppose an enormous amount of erosion to account for the entire absence of volcanic material above the sandstone. On the other hand, it is very easy to suppose that overlying sediments, on being subjected to pressure, were thrust up over the igneous rocks from the east. This explanation of the facts coincides with other evidence relative to the comparative age of the sedimentary and volcanic rocks.

(1) Nowhere in the South Mountain has there been found a dike of the volcanic material in the sedimentary rock. Were the lavas more recent than the sediments, the former could hardly fail of filling cracks in the latter.

(2) No sedimentary beds have been found intercalated with the lava flows.

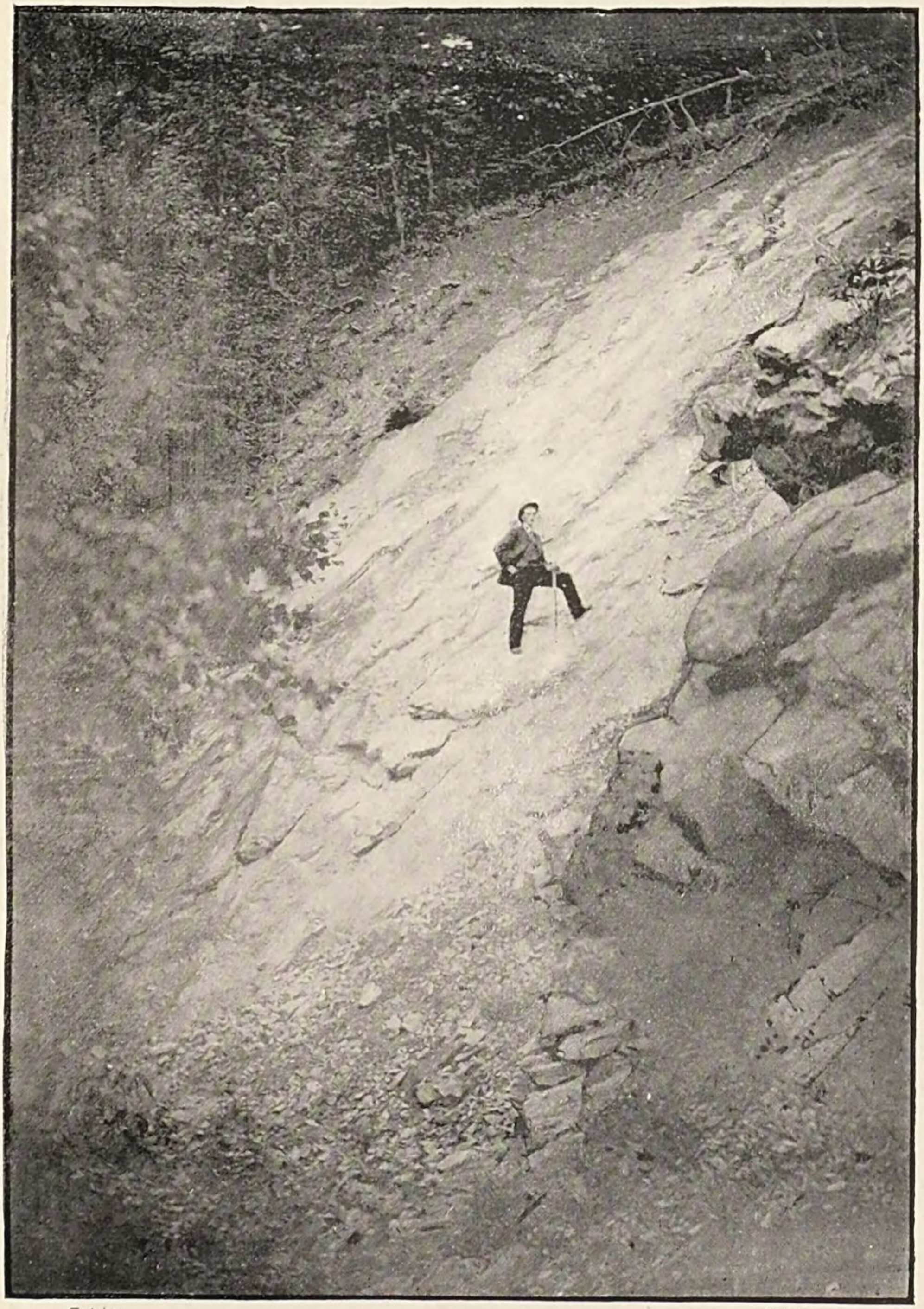
(3) There is no evidence of the alteration of the sedimentary rock by igneous contact.

(4) The igneous rocks, in their fluxion and amygdaloidal structures, and in their accompanying pyroclastics and ash deposits, bear every evidence of being *subaerial* lava flows.

(5) The presence of igneous fragments in the basal conglomerate of the sedimentary formation shows that erosion of the igneous rocks was taking place while the sediments were accumulating along their edges.

While it is true that some erosion of the eruptives must have taken place before and during the deposition of the Cambrian sediments, there is no evidence of extended erosion; indeed, the character of surface flows, which the lavas retain so conspicuously, would incline one to suppose that no great load of material has been removed. Mr. Keith's conception that the granite which in Maryland is intruded into the "diabase" (greenstone) is younger than the volcanics necessitates an immense original thickness of the diabase flows and an extended subsequent erosion to expose the plutonic eruptive. In this respect his argument for the comparative age of the deep-seated and surface igneous rocks seems at fault[1]. Such unlimited erosion is unsupported by field observations in the South Mountain.

[1] Geologic structure of Blue Ridge in Maryland and Virginia: Am. Geologist, Vol. X, 1892, p. 368.



Felsite. Sandstone.

JUNCTION OF FELSITE AND SANDSTONE ON THE OLD TAPEWORM RAILROAD.

COMPARATIVE AGE OF ACID AND BASIC ERUPTIVES.

FIELD RELATIONS.

The relative age of the acid and basic volcanics is an interesting question, a question to which it is not possible with our present knowledge to give an entirely satisfactory answer.

On the one hand we find the acid rocks occupying, as a rule, the lower altitudes, and even overlain by the basic rock. Occurrences of the latter nature are located as follows:

(1) At the junction of Gladhill's road and the Fountaindale turnpike, in the northeast angle of the roads, a slight excavation exposes an outcrop of gray, slaty felsite overlain by greenstone.

(2) Not far from the source of Minie Branch there is exposed by the cutting of the stream a gray felsite, overlain by greenstone.

(3) On the road from Fountaindale to Fairfield, southeast of Jacks Mountain, a much-altered felsite is overlain by greenstone.

(4) Lastly, on the Fountaindale turnpike, about half a mile above the Emmetsburg tollgate, the same superposition is exposed by the roadside.

The only published statement of opinion as to the relative age of the volcanics has been made by Mr. Keith.[1] From his observations of the relative positions of the acid and basic rocks in Maryland, Mr. Keith expresses himself as confident that the "quartz-porphyry underlies the diabase."

On the other hand, over against this somewhat meager proof must be considered a few facts of another sort. Professor Williams reports that a position of the acid and basic rocks the reverse of that which has been described in the Monterey district occurs north of that district. Throughout the northern portion of the range the acid eruptives, which abound almost to the exclusion of the basic eruptives, form the mountains, while the latter occupy the valleys.

We must, moreover, bear in mind that the principles of stratigraphy employed in determining the age of sedimentary rocks may prove very misleading if applied to igneous rocks. The younger lava may be found overlain by the materials of an earlier eruption where the former, in coming to the surface, breaks through the older formation. The latest eruption may fill the depressions.

Where two different lavas occur on the same level, as is the case south of the Clermont House, the lava (in this case the acid lava) occurring as a narrow strip inclosed by the other might be an intrusive eruptive, and thus younger than the inclosing basic lava.

PROBABLE EXPLANATION.

With these principles in mind, with conflicting field evidence, and in the absence of genuine dikes of either acid or basic character, the data for the determination of the comparative age of the acid and basic

[1] Loc. cit., p. 367.

volcanics are not sufficient. In all probability there were several sources of lava flow.

The southern vents furnished the great areas of basic lava (greenstones) in Maryland and southern Pennsylvania, while the northern vents poured out the enormous acid flows.

In the Monterey district the two lavas are mingled, and apparently the basic flow was preceded by the acid flow.

Thus the facts observed by Professor Williams in the north, Mr. Keith in the south, and the writer in the Monterey district, may be brought into accord.

SUMMARY.

Three types of rocks are present in the South Mountain: (1) Siliceous sedimentary rocks of Lower Cambrian age, overlying with structural conformity and stratigraphical unconformity igneous rocks. These igneous rocks are surface flows of (2) an acid and (3) a basic constitution. They are probably pre-Cambrian, and lithologically resemble the Keweenawan copper-bearing rocks of Lake Superior.

There is not sufficient evidence to decide their comparative age, though in the Monterey district field observations, on the whole, indicate that the acid rocks are the older.

The subaerial flows were subjected to a limited erosion before the sediments were deposited and while they were being deposited, so that the region must have possessed some elevation at that time.

The intense dynamic action shown by the igneous rocks occurred after the deposition of the sediments. Since the sediments were laid down the whole region has been subjected to lateral pressure (at the time of the Appalachian uplift), whereby the igneous rocks were cleaved and sheared and the sedimentary formation was thrust up over them from the east—where it has been largely eroded, occurring now only sporadically—and the whole region was elevated. That erosion has removed a great thickness of material since this elevation is indicated by the cleavage dips of the igneous rocks.

CHAPTER III.

PETROGRAPHICAL DESCRIPTION OF THE CAMBRIAN ROCKS.

MACROSCOPICAL DESCRIPTION.

The sedimentary formation exhibits two marked phases, the conglomeratic and the quartzose. Its lowest member is conglomeratic.

These conglomerates are frequently slaty, through the development of more or less sericite. They contain quartz pebbles from an inch to an inch and a half in length, and sometimes show included fragments of quartz-porphyry and of a green slate.

From a conglomeratic character the sediments pass through a coarse sandstone into a compact quartzite exhibiting under the microscope the characteristics of a recrystallized clastic.

The quartzose sandstone is exposed in great masses on the flanks and summit of Monterey Peak, on Haycock Summit, at the Gladhills Switch on the Gettysburg Railroad and at many points along the railroad as it skirts the east side of Jacks Mountain, and in massive pinnacles along the crest of that mountain. That the sandstone has been greatly fissured and broken is indicated by the conspicuous and frequent quartz veining, but metamorphism, save in a few cases, has been limited to the formation of a vitreous quartzite by the deposition of a siliceous cement. The original stratification planes are usually preserved, and cross bedding is frequently conspicuous. A secondary cleavage is also very marked, so much so as, in the absence of well-defined stratification planes, to be mistaken for the bedding.

MICROSCOPICAL DESCRIPTION.

QUARTZITE.

Four specimens of typical quartzite were studied in the thin section. They were obtained from widely separated localities, and range in color from gray to a light green. Two of them illustrate the enlargement of quartz fragments and the genesis of a quartzite as perfectly as do any of the Lake Superior sandstones.[1] (Pl. XV, *a*.)

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[1]Quartz enlargements were first described by Törnebohm, subsequently by Sorby, Young, Irving and Van Hise, Bonney, Phillips, and Iddings:

A. E. Törnebohm, Ein Beitrag zur Frage der Quartzbildung: Geol. Foren. Stockh. 1876, Vol. III, p. 35. Ref. Neues Jahrbuch für Mineral., 1877, p. 210.

H. Clifton Sorby: Anniversary Address, Quart. Jour. Geol. Soc. London, Vol. XXXVI, 1880, p. 62.

A. A. Young: Am. Jour. Sci., Vol. XXII, July, 1881.

R. D. Irving: Am. Jour. Sci., Vol. XXV, June, 1883.

R. D. Irving and C. R. Van Hise: Bull. U. S. Geol. Survey No. 8, 1884.

T. G. Bonney and J. A. Phillips: Quart. Jour. Geol. Soc. London, Vol. XXXIX, 1883, p. 19.

R. D. Irving and C. R. Van Hise: The Penokee iron-bearing series of Michigan and Wisconsin: Tenth Ann. Rept. U. S. Geol. Survey (1888-89), p. 375, Pl. XXVII, fig. 2.

J. P. Iddings: Mon. U. S. Geol. Survey, Vol. XX, 1892, pp. 346-347.

The original grains are conspicuously outlined by a rim of iron oxide and surrounded by interlocking areas which are optically continuous with the inclosed grain. Rarely the grain itself is composed of two differently oriented areas, in which case the enlargement is also composed of two different areas oriented with the two portions of the grain.

These same specimens show feldspar grains, usually with the "gridiron" structure of microcline. Occasionally a hornblende fragment is also present. The rock is evidently derived from granitic débris and might more accurately be called arkose. The fresh character of the fragments is in general noteworthy and suggests a source not far distant.

The best examples of the vitreous quartzite, the extreme phase of metamorphism in the sediments, are to be found in the tunnel at and in the neighborhood of the contact with the greenstone, and on the unfinished Tapeworm Railroad southwest of the Old Maria Furnace at the similar contact of the sandstone and felsite. At both of these localities the rock shows macroscopically and microscopically the effect of dynamic action. Of two specimens from the first locality, which has already been described in sufficient detail on page 27, one is a pure quartzite with prominent cleavage, on the surface of which iron rust is deposited. The thin section shows a quartzite from which every vestige of the original waterworn grains has been obliterated. The rock consists of interlocking areas of quartz and some interstitial material. This is a fine aggregate of quartz grains, and may be a remnant of the granulation which must have occurred as a result of the movement of the grains against one another.

A similar phenomenon in the sandstone of Sugar Loaf Mountain has been figured by Dr. Keyes.[1]

Another specimen from the same locality, but nearer the greenstone, shows a rock which, because of the shearing and chloritization that it has undergone, very closely resembles a chlorite schist. Its clastic character, however, becomes quite evident under microscopic examination. This shows it to be a siliceous rock, greatly sheared and altered in character by the formation of sericite and chlorite. It is the only section of quartzite in which chlorite has been observed. Its close proximity to the greenstone, in which that mineral is so abundantly developed, suggests a probable source of the magnesia, iron, and alumina. Tourmaline, zircon, magnetite, and feldspar are also present in this rock.

The quartzite at the felsite contact is similar, both in the hand specimen and in the thin section, to the first of the two specimens just described. No trace of the original grain remains. Undulatory extinction is pronounced and recrystallization complete. Specimens obtained close to the acid igneous rock differ only in the presence of a large amount of

[1] C. R. Keyes, A geological section across the Piedmont Plateau in Maryland: Bull. Geol. Soc. America, Vol. II, 1891, p. 321.

red iron oxide. The quartz crystals are frequently cracked, testifying to more intense dynamic action. The extreme induration at both these contacts is confined to a selvage of the sandstone.

SLATES.

In a cut on the Gettysburg Railroad, southwest of the Old Maria Furnace, the sedimentary rock is locally of a different character from that which has been described. It resembles the second specimen described from the contact in the tunnel more closely than any other of the clastics. Shearing has been accompanied by the development of sericite and chlorite, producing a soft, green, slaty rock. The chloritic areas have usually clearly defined boundaries, and possibly represent former hornblende grains. Zircon is present. The major part of the rock consists of quartz grains, with undulatory extinction.

Another local alteration of the clastic rock is to be found on the hill-tops southeast of Jacks Mountain. Here it appears as a yellowish schistose rock. The thin section is characterized by the development of a large amount of sericite and granular epidote. The sericitic scales show a parallel arrangement, which is the product of shearing. The color of the rock is due largely to an iron hydroxide.

Among the sedimentary rocks within the Monterey district there rarely occurs, associated with the sandstone, an argillaceous slate. This is exposed just north of Jacks Mountain Station. It is the only representative in the Monterey district of the interbedded slates occurring west of that district. It is silky, pearl-gray, crinkled, and cleaves readily into slabs.

The thin section shows that the rock has been somewhat recrystallized, though its clastic origin is still apparent in the angular shape of its quartz fragments. Quartz and sericite are the principal constituents of the rock. The other constituents are magnetite, hematite, and a gray cloudy aggregate which, under the highest power, obscurely suggests leucoxene and granular epidote.

CHEMICAL ANALYSIS.

The analysis of the quartzite given below shows proportions which would be possible only in a derivative rock where the exact chemical composition is a matter of accident and subject to no fixed laws.

The silica percentage is disproportionately high for any but a clastic rock. The alkalies indicate the presence of a considerable amount of either orthoclase feldspar or sericite, probably the latter. The alumina and lime percentages denote the presence of epidote.

Analysis of quartzite.[1]

	Per cent.		Per cent.
SiO_2 (quartz)	84.130	CaO.....	.040
SiO_2 (Combined) .	7.870	K_2O.....	1.160
TiO_2.....	.145	Na_2O	.160
P_2O_5	.205	Ignition	.960
Al_2O_3	4.210		
Fe_2O_3.....	1.800	Total	100.680

SUMMARY.

The Cambrian sediments of the Monterey district may be classified as conglomerate, sandstone, quartzite, and slate.

The first two of these phases represent original sedimentary deposits, of which the latter has been locally metamorphosed by induration into a quartzite. The slates are in some cases from deposits of a more finely divided material, and in other cases they are the product of shearing.

There has been a limited and local introduction of new material, which shows itself in the production of chlorite and epidote. In every case the clastic character of the rock remains indubitable.

[1] Specimen No. 1157, 1½ miles S. of W. of the burned sawmill on the Conococheague. This analysis was made by Dr. F. A. Genth, formerly of Pennsylvania University, for the Second Geological Survey of Pennsylvania, Vol. CCC, Second Geol. Surv. Pa.

CHAPTER IV.

PETROGRAPHICAL DESCRIPTION OF THE ACID ERUPTIVES.

NOMENCLATURE.

The question of the nomenclature of the acid volcanics has proved to be one of considerable interest and importance. In the discussion of suitable terms for the description of these rocks, it will be necessary to anticipate, in some degree, the results of their microscopic study. A variety of names have been applied by petrographers to the acid type of the older volcanic rocks. Under the general group of quartz-porphyries, Rosenbusch classifies them as *microgranites*, with a micrographitic groundmass; *granophyres*, with a micropegmatic groundmass; *felsophyres*, with a microfelsitic base; and *vitrophyres* (including pitchstones and pitchstone-porphyries), with a vitreous base. Fouqué and Lévy employ *microgranitite*, *micropegmatite*, and *porphyre petrosiliceux* as corresponding terms. British petrographers have described these acid rocks under the terms *hornstones*, *claystones* and *claystone-porphyries*, *felsites*, *quartz-felsites*, and *felsite-poryhyries*, agreeing in this respect with the older German usage, when they have not followed Rosenbusch. In America both German and English usages have been followed, with more or less confusing results. In the nomenclature of the South Mountain rocks an effort has been made to avoid such confusion and to use such a term or terms as shall accurately characterize them and all similar rocks.

Among the acid eruptives of South Mountain are typical representations of Rosenbusch's quartz-porphyries. Closely associated with them and impossible of separation by any sharp line of demarcation are acid rocks with every structural characteristic of modern lavas.

Although possessing some characteristics in common with the *felsophyres*, these ancient prototypes of the rhyolite can not be included under that term, since they have a holocrystalline groundmass. Inasmuch as many of the English *felsites* have been shown by Rutley, Allport, Cole, and Bonney to be devitrified obsidians and pitchstones, and thus, like the American rocks, representatives of the glassy lavas of pre-Tertiary times, these South Mountain lavas might, with some propriety, be termed felsites. Strict consistency would then compel the replacement of the term quartz-porphyry by the more limited and less well-established term quartz-felsite, which was felt to be a disadvantage. Moreover, the distinction between the rhyolitic lavas of

South Mountain and the typical quartz-pophyries is not one of the absence or presence of phenocrysts. Thus the term felsite would be forced to cover not only nonporphyritic acid rocks, but also conspicuously porphyritic rocks. Finally, felsite, though useful as a field name, may well be objected to as an inaccurate petrographical term.

A brief history of the word felsite and its synonyms in different countries (petrosilex, eurite, and hälleflinta,) will serve to illustrate the unfitness of it and these allied terms for exact petrographical usage.

"Felsit" was introduced into German petrographical nomenclature by Gerhard[1] in 1814, who applied the term to a matrix which he claimed was common to all feldspar, claystone, and hornstone porphyries. This matrix was a compact homogeneous aggregate of feldspar and quartz, supposed by Gerhard to be compact feldspar.

In 1858 Naumann[2] adopted Gerhard's word for the feldspar-quartz groundmass, and called all porphyries with such a base felsite-porphyries. This term has since been applied by Tschermak to porphyries without quartz phenocrysts (orthofelsites, orthophyres).

The more accurate German usage of the present day discards felsite save as a macroscopic term for an unresolvable porphyry base,[3] while "felsitfels" is used if, in the absence of phenocrysts, the rock is composed of this base only.[4]

This same quartz-feldspar mosaic, confused with compact feldspar, was distinguished as petrosilex by Wallerius[5] as early as 1747, and subsequently by Dolomieu. This term was also early used by Brongniart. In 1819 the same groundmass was called eurite by Daubisson[6] because of its fusibility. Michel-Lévy[7] uses the term petrosilex, but with a more limited meaning. He defines it as essentially synonymous with Rosenbusch's microfelsite, making "porphyre petrosiliceux" equivalent to felsophyre. Petrosilex is, however, generally used by Lévy and other French petrographers in a more or less loose and vague way, to cover a crystalline or cryptocrystalline quartz-feldspar aggregate or a partially amorphous siliceous feldspathic magma.

In Sweden, the fine-grained, apparently homogeneous acid rocks consisting essentially of quartz and feldspar and rarely porphyritic, are called hälleflinta.[8] They may be of aqueous or of igneous origin.

The early meaning of *felsite* in England was quite similar to that given it on the Continent. According to Pinkerton[9] the term was

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[1]Beiträge zur Geschichte des Weissteins des Felsit und anderer verwandten Arten: Abhandl. K. Akad. Wiss. zu Berlin, 1814, 1815, pp. 18–26.

[2]Lehrbuch der Geognosie, 2d ed., Vol. I, 1858, p. 597.

[3]Rosenbusch, Mikro. Phys., etc., 2d ed., Vol. II, p. 373.

[4]Rosenbusch, loc. cit., p. 354.

[5]Systematica Mineralogicum, 1847, French translation, 2 vols., Paris, 1853.

[6]Traité de géognosie, 1st ed., Vol. I, 1819, p. 112.

[7]Structures et classification des roches éruptives, p. 17.

[8]Justus Roth, Allgemeine und chemische Geologie, Vol. II, p. 494. F. Zirkel, Lehrbuch der Petrographie, Vol. I, p. 564.

[9]T. Pinkerton, Petralogy, A Treatise on Rocks, Vol. I, 1811, p. 161.

introduced in 1794 by Kirwan [1] for compact feldspar. Current usage as defined by Teall [2] applies the term to "compact stony rocks, the mineral composition of which can not be ascertained by examination with the naked eye or with the lens. * * * These rocks are anhydrous (or nearly so), and except in this respect agree in composition with the acid glassy lavas."

Dana [3] (as an exponent of American usage) defines "felsyte," a rock, as "compact orthoclase with often some quartz intimately mixed, fine granular to flint-like in fracture, * * * both metamorphic and eruptive." The mineral he defines as follows: "Felsite is compact, uncleavable orthoclase, having the texture of jasper or flint, which it much resembles. It often contains some disseminated silica. It is distinguished from flint or jasper by its fusibility. * * * It is the base of much red porphyry." This is substantially the "felsitfels" and "felsit" of Rosenbusch.

In short, "felsite" has been used to describe an acid base, unresolvable by the naked eye, and once supposed to be a single mineral. With the introduction of the microscope this macro-"felsitic" base was resolved into the microgranitic, micropegmatitic, and microfelsitic groundmass, the point of ignorance having been shifted from the felsitic base, macroscopically unresolvable, to the microfelsitic base, which is microscopically unresolvable.[4]

On the Continent "felsite" has practically been replaced by these terms. British and American petrographers retain it as a useful field name for rocks formed of this macroscopically unresolvable base without phenocrysts or with inconspicuous phenocrysts. In this sense the word will be used, when used at all, in this paper.

It is very generally recognized that structural features are not conditioned by the geological age of rocks, but are a function of the conditions of consolidation. That these conditions, while very varied and complex in any geological period, have not essentially altered since Paleozoic times, has been shown to be the case by some of the most able observers.[5]

With this recognition has come the growing conviction among petrographers that mere age should be eliminated as a factor in geological nomenclature. While this is true, it is felt on the other hand that the rock name should show some recognition of the alteration

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[1] Richard Kirwan, Elements of Mineralogy.

[2] J. J. Harris Teall, British Petrography, p. 291.

[3] J. D. Dana, Manual of Mineralogy and Lithology, 3d ed., 1883, pp. 280, 442. Manual of Geology, 3d ed., 1879, pp. 73, 77.

[4] Rosenbusch does not assent to this interpretation of microfelsite, but regards it as a definite chemical compound allied to feldspar, just as felsite was once regarded.

[5] Teall, Address of the Pres. of the Geol. Soc. of the British Ass. Adv. Sci., 1893.

Judd, On the gabbros, dolerites, and basalts of Tertiary age in Scotland and Ireland: Quart. Jour. Geol. Soc., London, Vol. XLII, 1886, pp. 49–97.

Allport, Tertiary and Paleozoic trap rocks: Geol. Mag., London, 1873, p. 196. British Carboniferous Dolerites: Quart. Jour. Geol. Soc., London, Vol. XXX, 1874, pp. 529–567.

Iddings and Hague, On the development of crystalization in the igneous rocks of Washoe, Nev., with notes on the geology of the district: Bull. U. S. Geol. Survey No. 17, 1885

which the rock has undergone subsequent to its solidification. If at the time of its solidification the rock presented the features of a rhyolite, as is believed to have been the case with much of the South Mountain acid lava, but since that time has become holocrystalline, both these facts—its original character and its present character—should be recognized in the name. It is believed that this result may be secured by the retention of such well-established names as rhyolite, obsidian, trachyte, etc., preceded by a prefix which shall have such a signification as will indicate the altered character of the rock. The prepositions *meta*, *epi*, and *apo* all indicate, as prefixes, some sort of an alteration. Their exact force has been thus defined by Professor Gildersleeve. *Meta* indicates change of any sort, the nature of the change not specified. This accords with the use of the prefix by Dana in such terms as "metadiorite" and "metadiabase." These terms have been recently revived to designate "rocks now similar in mineralogical composition and structure to certain igneous rocks, but derived by metamorphism from something else."[1]

Epi signifies the production of one mineral out of and upon another. This prefix has not been much used. We find it in such terms as epidiorite, epigenetic hornblende, and epistilbite. *Apo* may properly be used to indicate the derivation of one rock from another by some specific alteration.

If, therefore, we decide to employ this prefix to indicate the specific alteration known as devitrification (Entglasung) we may obtain, by compounding it with the names of the corresponding glassy rocks, a set of useful and thoroughly descriptive terms like aporhyolite, apoperlite, apobsidian, etc., as to the exact meaning of which there can be no doubt.

In accordance with this usage, it is proposed in this paper to call all the acid volcanic rocks the structures of which prove them to have once been glassy, *aporhyolites*, while such as were originally holocrystalline, or whose original character is in doubt, will be termed quartz-porphyries.

The writer feels that the introduction of a new name into petrographical literature is to be deplored unless it can be shown that the name is formulated in accordance with certain well-defined principles. A good rock name should express composition, original structure, and as far as possible the process of alteration, if alteration has occurred. It is thought that aporhyolite and the suggested series of similarly formed terms meet these requirements. They are therefore adopted as preferable to any in present use.[2]

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[1] Whitman Cross, "On a series of peculiar schists near Salida, Colo.:" Proc. Colo. Sci. Soc., Jan., 1893, p. 6.

[2] Since the above was written the term eorhyolite has been proposed by Dr. Nordenskjöld to cover ancient acid volcanics identical with those of the South Mountain. In a review of Dr. Nordenskjöld's able paper, "Ueber archæische Ergussgesteine aus Småland" (Bull. Geol. Instit. Upsala No. 2, vol. 1, 1893), the writer has discussed the disadvantages that attend the use of any term or series of terms which carry with them the idea of age. The reader is referred to this review, which appeared in the American Geologist for March, 1896, pp. 179–184, for a fuller statement of the writer's idea of the relation existing between devitrification and age of volcanics.

It is a question whether it is always possible to distinguish between a primary and a secondary crystalline groundmass, and no attempt has been made to draw a sharp line between the quartz-porphyries and the aporhyolites. In the absence of some of the more marked structures of a glass the presence of a secondary crystalline structure has not been considered sufficient evidence for the completely secondary character of the crystallization. It is very probable that while a large portion of the lava flow consolidated as a glass, much of the lava solidified at a sufficient depth to have secured a holocrystalline groundmass.

QUARTZ-PORPHYRIES.

DISTRIBUTION.

A deep-red porphyry outcrops along the turnpike leading from the west to Monterey Station, and covers a small area north of the high-road.[1] One mile north of this, in the neighborhood of "Gum Spring," there are several limited areas of blue, purple, and brick-red porphyries. About 4 miles northeast, on the "Old Furnace Road," by the unfinished viaduct, is a large area of dark-blue porphyry, passing toward the southwest by insensible gradations into typical aporhyolites.

These are the more important areas of porphyries. There are other porphyries so closely associated with the devitrified glassy lava that they will not be separately located.

MACROSCOPICAL DESCRIPTION.

The beauty and variety of color of these porphyries have already been noted. The phenocrysts are not large (5 to 11 mm long), but are conspicuous against the dark or brilliantly colored matrix. The orthoclase phenocrysts are opaque white, pink, or brick-red. They usually possess a well-defined crystalline outline and show twinning in the hand specimen. The quartzes are colorless or a rich wine-red. The fracture is conchoidal and there is a less-marked tendency to cleavage than in the aporhyolites.

The porphyries show a reddish-brown color on the weathered surface, and on decomposing form a red earth. The presence of manganese is abundantly exhibited in dendritic markings on the cleavage surfaces. This is especially true in the case of the slates developed from the porphyries. (Pl. XIV.)

MICROSCOPICAL DESCRIPTION.

PHENOCRYSTS.

Feldspar.—The porphyritical feldspars are more abundant than the quartz phenocrysts, and are remarkably fresh and unaltered. That they belong to the group of alkali feldspars, and that both monoclinic and triclinic varieties are undoubtedly present, are indicated by chemical analysis (given on page 61), by their specific gravity, and by their

[1] See the geological map of the Monterey district accompanying this bulletin, Pl. III.

optical properties. Feldspar crystals were separated from specimens of the porphyry taken from different localities and their specific gravity was determined. The range was from 2.6 to 2.62. On account of the presence in the heavier feldspars of minute inclusions of piedmontite, the lowest specific gravity was considered to represent the purest feldspar.

Twinning is very common, according to either the Carlsbad or Manebacher (pericline) laws. Pl. XV, *b*, shows a Manebacher penetration twin of feldspar. The section is nearly parallel to the clinopinacoid, as the following observations indicate: The axis of least elasticity makes an angle with the twinning line (rhombic section) of about 15 degrees on one side and 21 degrees on the other; the obtuse positive bisectrix emerges. There is a slight trace of a basal cleavage and a microperthitic intergrowth parallel to *c*. The position of the plane of the optic axes, the distribution of the axes of elasticity, and the specific gravity all indicate that the crystal is the triclinic soda feldspar anorthoclase.

The resemblance to this of the other feldspar phenocrysts makes it probable that this is the prevailing feldspar. Other sections show the albitic intergrowth (microperthite) developed in a pronounced manner (Pl. XVI, *a*). Every gradation of this structure is present, from the microperthitic to the cryptoperthitic. Sometimes the perthitic growth does not persist throughout the crystal, but is present in an incipient stage along its edge.

The feldspars are often cracked and drawn apart in the direction of the schistosity of the rock, and the cracks cemented with sericite scales whose parallel arrangement conditions the schistosity (Pl. XVI, *b*). This is most striking in porphyry obtained 40 feet below the surface, which shows an abrupt passage into a sericite-schist. The phenocrysts are crushed and pulled apart. This action had been accompanied by an abundant development of sericite. Some of the phenocrysts possess in the hand specimen a red color, which is due to a fine admixture of red iron oxide. These phenocrysts frequently prove, from a test of their optical properties, to be orthoclase.

The alteration of the feldspars to epidote may indicate the presence of lime in the feldspar. Undoubtedly, however, much of the lime is of secondary origin. This alteration of feldspar to epidote seems to be a direct one. There is no intermediate kaolin stage, such as observed by Rutley.[1] Accompanying the epidote is granular quartz. These two alteration products usually occupy the center of the crystal and are surrounded by a rim of unaltered feldspar.

Brilliantly colored piedmontite frequently fills cavities in the feldspar crystals. This mineral is often surrounded by a rim of epidote.

Quartz.—The bipyramidal or rounded quartz phenocrysts are remarkable only for their undulatory extinction and the cracks by which strain

[1] Rutley, On some perlitic felsites and on the possible origin of some epidosites: Quart. Jour. Geol. Soc. London, Vol. XLIV, 1888, pp. 741-742.

has been relieved. They are fresh and show characteristic embayments and inclusions. Like the orthoclase, they are sometimes reddened by inclusions of hematite, or are more rarely given a rich wine-red color by inclusions of piedmontite.

GROUNDMASS.

The holocrystalline groundmass of the porphyries consists essentially of quartz and feldspar. These minerals form either a finely micrographic mosaic or a structure which becomes of considerable interest in connection with the question of the original character of the crystallization.

In the first case there is no reason per se for supposing the crystallization to be other than primary. It is only as the crystallization is associated with secondary structures, or structures testifying to a primitive glassy condition, that the presumption favors its secondary character. When the crystallization is micrographic and presumably primary, the rock is a genuine quartz-porphyry.

The structure alluded to, which occasionally replaces the quartz-feldspar mosaic in the porphyries, is the micropoikilitic,[1] where all the quartz of the groundmass has crystallized in irregular areas inclosing the feldspar as lath-shaped microliths. These feldspar microliths are oriented quite independently of one another. This structure characterizes the aporhyolites, and the question of its primary or secondary character will be fully discussed in connection with these rocks.

The alteration of the groundmass to sericite and the formation of a sericite schist will be discussed in connection with the acid slates.

ACCESSORY CONSTITUENTS.

Piedmontite (manganese epidote) is the most remarkable of the accessory constituents. It is not only disseminated in microscopic quantities through the deep-red porphyry, but it also occurs in macroscopic masses, as a radiating aggregate, filling veins and cavities in the red felsite or replacing spherulitic crystallization.

Two localities in the Monterey district furnish a great abundance of the piedmontite: the southwest flank of Pine Mountain, 1 mile northeast of Monterey station, and the hillside south of the Clermont House, between the turnpike and Minie Branch. Microscopic sections of the aggregate show brilliantly colored needles of piedmontite intergrown with clear quartz. (Pl. XXV, *b*.) This intergrowth with quartz is also marked in the hand specimen. The radiating needles have the appearance of being broken, stretched apart, and the spaces filled with secondary quartz. The only other locality where piedmontite was found in macroscopic quantities is in the Buchanan Valley, 2 miles north of

[1] G. H. Williams, On the use of the terms poikilitic and micropoikilitic in petrography: Jour. of Geol., Vol. I (No. 2, Feb.-March, 1893), pp. 176-179.

the Chambersburg turnpike, and one-eighth mile west of Musser's store. Piedmontite occurs here in cavities associated with scheelite.[1]

Epidote is also abundantly present in the porphyries, passing by gradations of rose-colored epidote to the deep carmine of the piedmontite. Both of these silicates are undoubtedly secondary products.

Innumerable black globulites of manganese oxide and black and red iron oxide crowd the groundmass. In their arrangement they show fluxion structure, or form meshes inclosing the quartz areas which constitute a part of the micropoikilitic structure. This arrangement is sometimes so marked as to be conspicuous in the hand specimen, giving the rock a mottled appearance. Crystals of zircon are not infrequently present.

A study of the quartz-porphyries of the South Mountain shows us that they are present there in characteristic development, and offer no marked variations from the normal type described from other localities. For this reason a brief space only has been devoted to them.

APORHYOLITES.

DISTRIBUTION.

There remains to be described a large and important portion of the acid rocks of the Monterey district. These will be termed aporhyolites, for reasons already suggested and to be more fully discussed in the sequel.

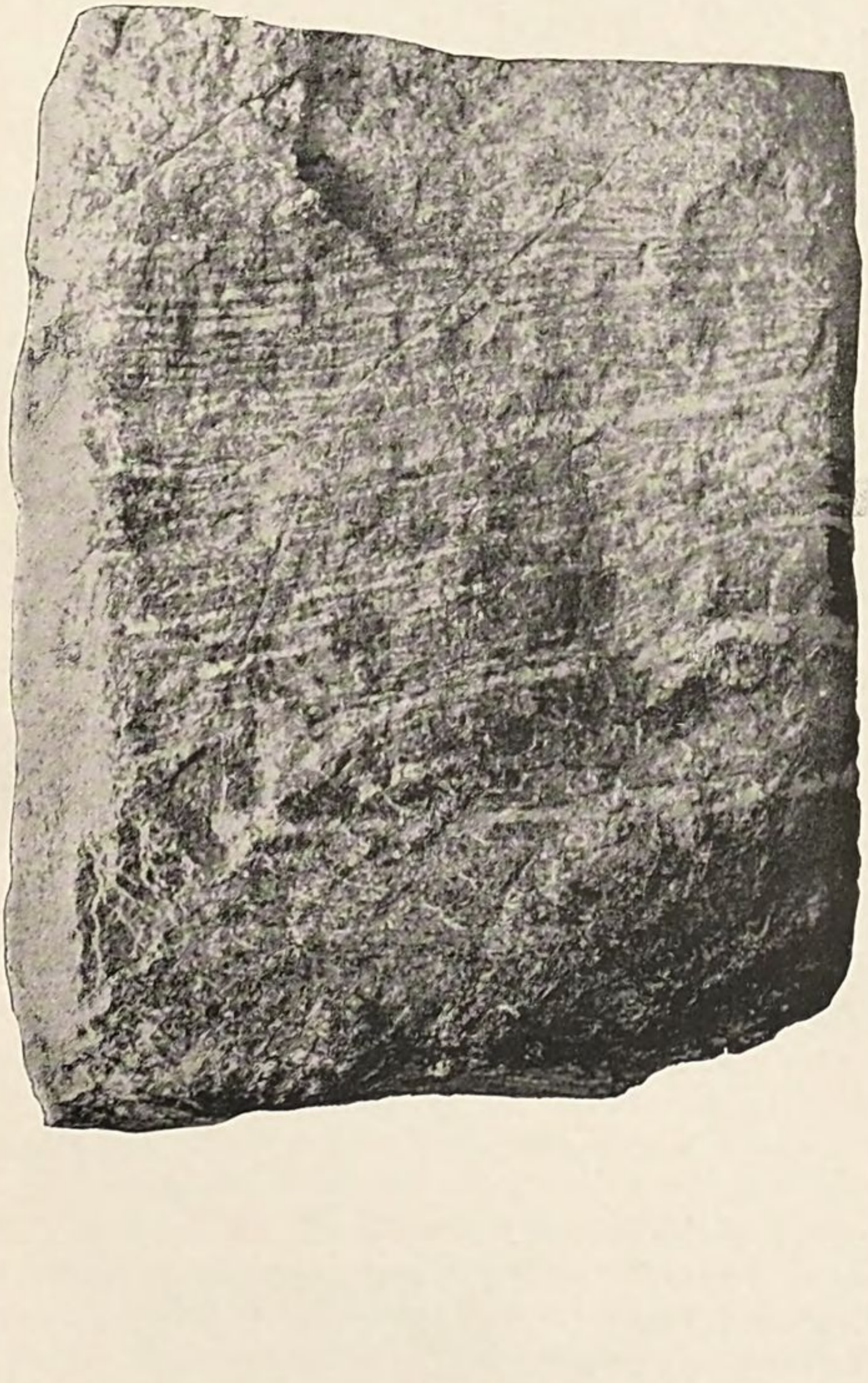
The localities colored red upon the geological map of the Monterey district (Pl. III) are aporhyolitic areas associated, in the cases already mentioned, with quartz-porphyries. The largest area begins just south of the Bigham copper mine, and, widening toward the north, extends far beyond the Monterey district. This area furnishes most of the spherulitic structures. A small detached area south of the Clermont House furnishes slaty and spherulitic aporhyolites. These aporhyolites and those of the four detached areas near the Maryland State line, separated from each other by a distance of a mile to a mile and a half, show some marked points of resemblance, to which attention will be called later.

The areas covering the foothills southeast of Jacks Mountain show an altered aporhyolite. There are several small areas of red aporhyolite on the Gladhill road leading to the Bigham property. At the forking of this road with the Fountaindale turnpike occurs the aporhyolite slate mentioned on page 29.

MACROSCOPICAL DESCRIPTION.

The aporhyolites have about the same range in color as the porphyries, varying from light bluish-gray, or buff, to many shades of red and purple. While usually compact and always fine-grained, they are

[1] G. H. Williams Piedmontite and scheelite from the ancient rhyolite of South Mountain, Pennsylvania. Am. Jour. Sci., Vol. XLVI, 3d series, July, 1893, pp. 50-57.



FLOW STRUCTURE IN APORHYOLITE, MONTEREY DISTRICT.

Four-fifths natural size. The specimen is deep red, with lines of flow in pink.

also sometimes very vesicular. In the latter case the amygdules of dark-green epidote and clear quartz, elongated by fluxion and conspicuous against a pale-pink background, render the rock strikingly handsome. Phenocrysts are usually present, but generally inconspicuous.

Delicate lines of flow structure, which are brought out in great detail by weathering or are painted in rich colors on the material washed by the mountain brooks, are another marked feature of the aporhyolites. These flow lines are frequently very sinuous, showing contortion and crumpling of the lava. (Pls. VII and VIII.) The flowage is often emphasized by the mingling of two contrasting magmas, forming taxites of either a eutaxitic or an ataxitic character. A fuller description of these taxites is given on page 57.

Another characteristic which these aporhyolites possess in common with their modern analogues is the spherulitic structure. Spherulites are rarely, if ever, altogether absent, and in some localities they are crowded so close together as to constitute the major part of the rock mass. They range in size from microscopic dimensions to those of a butternut. Where there is no regularity of arrangement and they are brought out in relief by weathering, the rock has a superficial resemblance to a conglomerate composed of rounded pebbles of remarkably uniform size (BB shot) and shape. (Pl. IX.) The rich grays and blues and purples of the spherulites and matrix render this a conspicuous rock. Other specimens from the same locality (the south flank of the mountain northeast of the junction of Copper Run and Toms Creek) show spherulites elongated by flow. They are thus drawn out into solid cylinders with a diameter of 1^{mm} and a length of some 2^{cm}.

Specimens of aporhyolites composed of spherulites about the size and shape of almonds (18^{mm} by 9^{mm}) were also found. The rock had been greatly sheared and the spherulites flattened.

Spherulites become a still more striking feature of the aporhyolites when arranged in layers which traverse the face of the rock in long, parallel, dotted bands. This arrangement has been described by Iddings in the obsidian of the Yellowstone National Park.[1]

While sometimes these bands are 4^{mm} wide, at a nearly uniform distance apart, and of an indefinite length, in other cases they are very narrow, dwindling into mere lines and dying out, to be succeeded by other lenticular bands. (Pl. X.) The planes of these spherulites have become planes of weakness and solution. The rock cleaves readily parallel to them and shows a coating of secondary silica on the cleavage surfaces. This deposition of silica causes these planes to become the hardest part of the rock, and hence they often stand out as parallel ridges on the weathered surfaces.

At the locality mentioned on pages 41–42, piedmontite, in radiating needles, associated rarely with scheelite, has, together with quartz, been

[1] Obsidian Cliff: Seventh Ann. Rept. U. S. Geol. Survey, 1888, p. 276, Pl. XVIII.

deposited along these planes of former spherulitic crystallization. The silica occupies the center of the deposit and gives rise to ridged surfaces. These layers of spherulites do not always lie in a single plane. Cross sections of the layers show irregular and minute sinuosities, which were doubtless caused by movement in the lava during consolidation.

The bands consist always, when not composed of piedmontite, of a central dark line (impurities) with a lighter band (opaque quartz) on either side. These in turn are bordered by dark lines (iron oxide) (Pl. X). This parallel banding, conspicuous even at a considerable distance, though recognizable as a true igneous structure by one familiar with the acid lavas of the Yellowstone National Park or of the Lipari Islands, counterfeits a sedimentary structure so closely that it is not surprising that the rocks should be described as "bedded orthofelsites."

Still other specimens show spherulites with a tendency to an arrangement in rows and chains which are in turn collected in bands some 2 inches in width traversing the rock and alternating with bands approximately free from spherulites. This arrangement differs from the layer spherulites in the fact that the outline of individual spherulites is quite distinct and the grouping irregular.

Some fine examples of the lithophysal structure were found in the Raccoon Creek region (Pl. XI). Nothing that could be definitely recognized as lithophysæ was observed in the Monterey district.

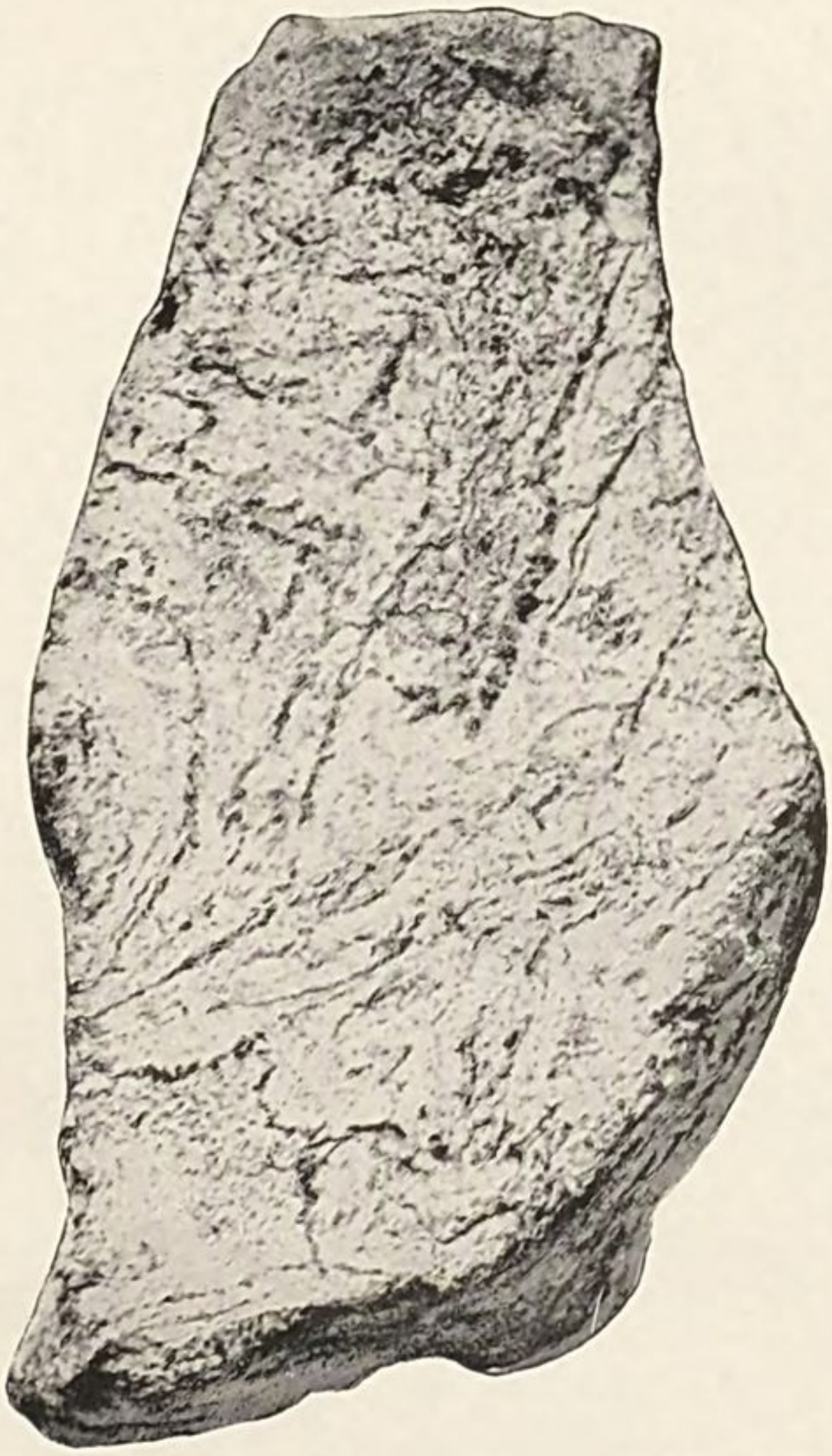
In the areas southeast of Jacks Mountain the aporhyolites have been more or less silicified or epidotized, or both, and are sometimes very difficult to distinguish, in the hand specimen, from the neighboring sandstone. A good example of this rock is seen in the exposures on the turnpike about one-fourth of a mile above the Emmitsburg tollgate, where silicification has produced a close resemblance to a quartzite. The fresh surface is white. Feldspar phenocrysts are sparsely distributed and scarcely discernable. Quartz blebs are more numerous. Pyrite is finely disseminated, and the exposed surfaces of the rock are tinged with yellow and red iron oxide. The rock cleaves in two directions oblique to each other. In this respect it resembles many of the felsites.

The microscopic evidence of igneous character is supported by the field evidence, which shows a continuity between this altered rock and that which would be at once recognized as a felsite.

MICROSCOPICAL DESCRIPTION.

PHENOCRYSTS.

Feldspar and quartz.—The feldspar phenocrysts are very like the feldspars of the quartz-porphyries, and little needs to be added to the description of them already given. They are fresh, contain inclusions of a once glassy magma, show perthitic intergrowth, and are twinned in accordance with the Carlsbad (albite) and Manebacher (pericline) laws.



FLOW STRUCTURE IN APORHYOLITE, RACCOON CREEK. NATURAL SIZE.

The specimen is light pink, showing on a smooth, weathered surface delicate and sinuous lines of an original flow structure, in shades of red and purple.

In the former case the twinning is sometimes repeated, and furnishes another indication of the triclinic character of the feldspar.

The feldspars are frequently bent or broken, causing the twinning striations to show curvature and faulting. Occasionally a phenocryst has been completely broken, the fragments pulled apart, and the space filled with a quartz-albite mosaic of much coarser grain than the groundmass, and evidently of subsequent formation. (Pl. XVII, *a*.) A complete replacement of the feldspar crystal by a quartz mosaic sometimes occurs.[1]

The quartz phenocrysts have rounded outlines and characteristic embayments and inclusions; undulatory extinction is almost universal; frequently the quartzes are cracked, and sometimes completely granulated. Both the porphyritical constituents of the aporhyolites give rise, in connection with curving flow lines, to the "augen" structure which has often been described.[2]

These flow lines leave clear, triangular spaces on one side of the phenocrysts, such as Futterer describes.[3]

Other porphyritic constituents.—The only ferromagnesian silicate unmistakably present in the aporhyolites is biotite. This was found in sections representing three different areas of acid volcanics which lie along the southern limit of the Monterey district. The first area is a small one at the head of Minie Branch. The second area is larger and caps the mountain southeast of Raven Rock Mountain. The third area is directly to the east of this, on Friends Creek. The lavas of these three localities show a marked similarity, both in the hand specimens and in the thin sections. They are compact, dirty-gray rocks, weathering a yellowish-gray. Feldspar phenocrysts are somewhat sparsely and inconspicuously present. On a fresh surface biotite can be detected with the naked eye. Magnetite is present, and in one of two specimens from the mountain locality pyrite is abundant in minute crystals.

All of the thin sections of these rocks are distinguished by finely striated feldspars. The carlsbad and pericline twinning are sometimes both present in a single crystal. Quartz phenocrysts are not numerous.

The presence of titanic iron oxide in abundance is attested by the formation of leucoxene. The groundmass is holocrystalline and finely micrographic, with a tendency toward the micropoikilitic structure. This tendency is fully developed in one of the sections. The hand specimen, from which this section was cut, shows a rock more completely silicified than the other specimens indicate, and also contains pyrite, which is indicative of secondary crystallization.

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[1] Similar replacements have been described by Dr. Milch, Beiträge zur Kenntnis des Verrucano, 1892, p. 126,

[2] J. Lehmann, Untersuchungen über die Entstehung der altkrystallinischen Schiefergesteine, Bonn, 1884. G. H. Williams, Bull U. S. Geol. Survey No. 62, pp. 85, 118, 207, Pl. XV, fig. 1.

[3] Karl Futterer, Der "Ganggranit" von Grossachsen und der Quartz-porphyr von Thal im Thüringer Wald, Inaug. disser., 1890, p. 32.

There is some epidotization of the groundmass, resulting in the production of finely granular epidote concentrated at certain centers of development.

The mica by which these lavas are characterized has a fibrous character, and is the andesitic type described by Rosenbusch.[1] It is in idiomorphic clusters of reddish-yellow fibers. The absorption is characteristically strong and the pleochroism marked. Parallel to the cleavage the fibers show a deep reddish-brown color, and at right angles a light yellowish-red or straw-yellow color. The marked resemblance of the lava from these localities suggests a continuity in the lava flow—a continuity probably maintained underneath the greenstone.

If this is the case these areas are exposed by erosion of the overlying basic lava, if it ever completely overlay the aporhyolite. That the continuity was maintained above the greenstone is a scarcely tenable hypothesis, because of the extended erosion which such a superposition would necessitate.

If any other ferromagnesian constituents were present in the aporhyolites—and there are indications that there were—they have been totally decomposed and removed.

Harker[2] found it to be true of the pre-Cambrian acid volcanics of Wales, that clusters of biotite flakes were preserved in a comparatively fresh condition, while only slight trace of augite or hornblende remained.

In the South Mountain aporhyolites these minerals must have been rare originally, and are now completely replaced by epidote. Occasionally the outline of a perfect crystal section parallel to 010 is preserved, while the substance of the crystal is entirely replaced by epidote individuals. In the absence of basal sections there is no clue to the specific character of the original crystal.

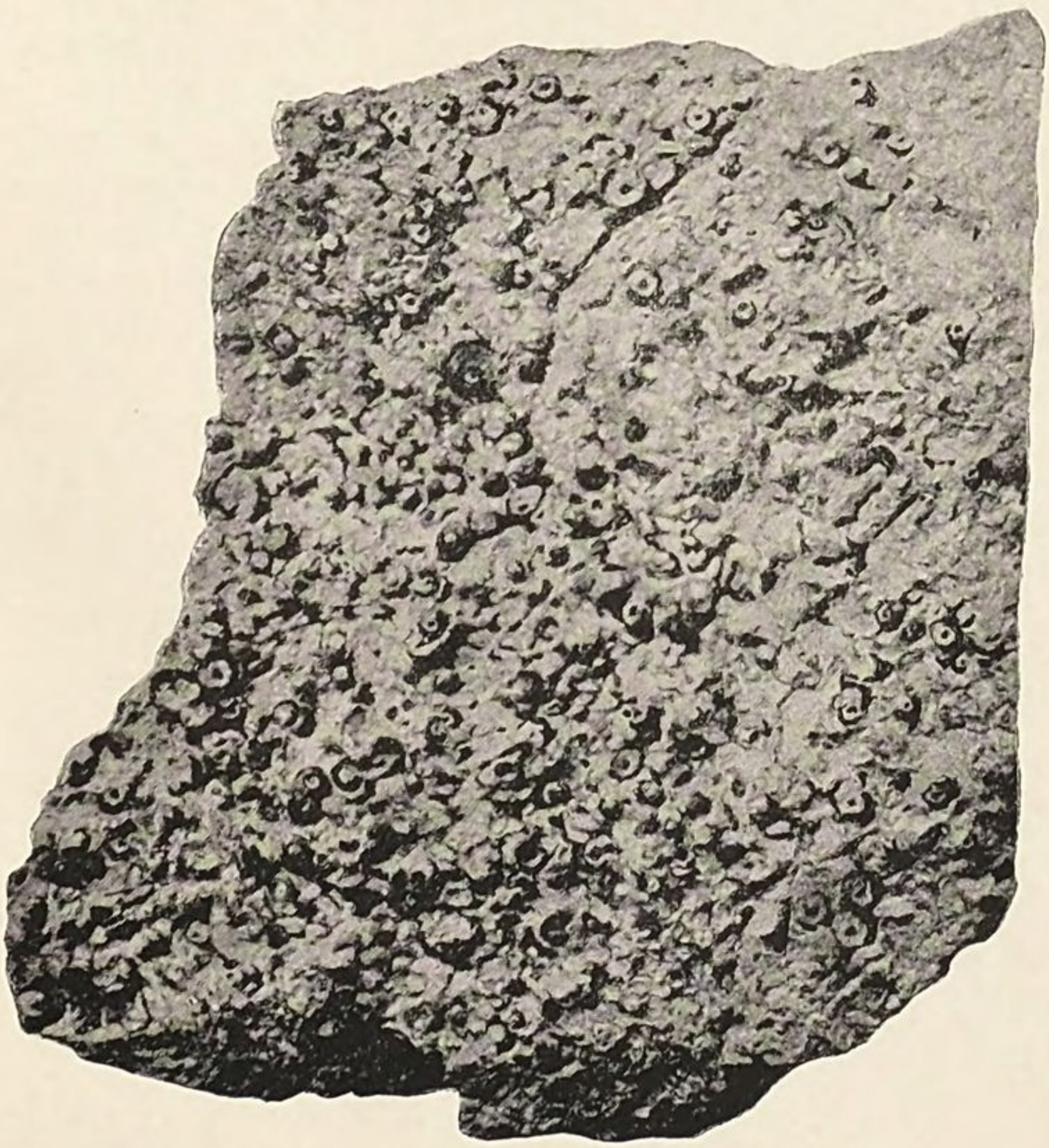
GROUNDMASS.

The groundmass is always a quartz-feldspar aggregate, of varying structure and grain (about $\frac{1}{85}$ of a millimeter in diameter), more often finely than coarsely microgranitic. The structures of the groundmass are of the highest interest and importance in their disclosure of the original character of the rocks which possess them.

The fluidal, micropoikilitic, spherulitic, axiolitic, lithophysal, rhyolitic, micropegmatitic, perlitic, taxitic, amygdaloidal, and trichitic structures are characteristically developed and merit detailed description.

Fluidal structure.—The fluidal structure, which is so familiar to all students of rhyolitic lavas, is a conspicuous feature of the aporhyolites, both macroscopically, as has been described, and microscopically. Globulites of magnetite and hematite and indefinable opaque crystallites follow sinuous lines of flow, twisting around the phenocrysts and

[1] Rosenbusch, Massige Gesteine, 2d ed., Vol. II, p. 658.
[2] Bala Volcanic Series of Rocks, p. 18.



SPHERULITIC APORHYOLITE, MONTEREY DISTRICT.

Seven-tenths natural size.

imparting to them the appearance of eyes, previously mentioned. Pl. XVIII, *a*, is the reproduction of a photomicrograph of a section showing this structure.

Micropoikilitic structure.—The micropoikilitic structure has been defined in connection with the quartz-porphyries, where it was not infrequently a significant feature of the groundmass. It is still more characteristic of the aporhyolites, and is occasionally present in the basic eruptives.

These irregular quartz patches, inclosing microlites of lath-shaped feldspars or other minerals of independent orientation, give a pronounced mottled or "patchy" appearance to the groundmass, an appearance which has been noted in volcanics of all ages. It has been observed and variously described, usually without being named, in quartz-porphyries, felsites, porphyrites, rhyolites, and peridotites, by numerous writers—Irving,[1] Williams,[2] Haworth,[3] Cross,[4] Iddings,[5] Diller,[6] Lindgren,[7] Teall,[8] Harker,[9] Brögger,[10] and Nordenskjöld.[11] Felsite from the Archean rocks of Georgia shows the same structure.[12] This structure is likewise present in the felsites from the neighborhood of Boston,[13] as is the case also with the quartz-porphyries and felsites of Marblehead Neck, Massachusetts.

An acid lava of the Keweenawan series from Minnesota, recently examined by the writer, shows with a high power and polarized light the micropoikilitic structure in perfection.[14]

While the term micropoikilitic is not restricted to a quartz-feldspar

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[1] R. D. Irving, Copper bearing rocks of Lake Superior: Mon. U. S. Geol. Survey, Vol. V, 1883, pp. 99–100, Pl. XIII, figs. 13 and 14.

[2] G H. Williams, Neues Jabrbuch für Min. u Pet., Supp. Vol. II, 1882, p. 607, Pl. XII, fig. 3. The peridotites of the Cortlandt series: Am. Jour. Sci., Vol. XXX, p. 30; Vol. XXXIII, p. 139.

[3] E. Haworth, A contribution to the Archæan geology of Missouri: Am. Geologist, 1888, Vol. I, p. 368, Pl. I, figs. 1 and 2; also, Crystalline rocks of Missouri: Ann. Rept. Mo. Geol. Survey, Vol. VIII, 1894, p. 195, Pl. XXII.

[4] Whitman Cross, On some eruptive rocks from Custer County, Colo.: Proc. Colo. Sci. Soc., Vol. II, 1888, pp. 232, 242. On a series of peculiar schists near Salida, Colo.: Proc. Colo. Sci. Soc., Jan., 1893, p. 8.

[5] J. P. Iddings, The eruptive rocks of Electric Peak and Sepulchre Mountain, Yellowstone National Park: Twelfth Ann. Rept. U. S. Geol. Survey, pp. 589, 646.

[6] J. S. Diller, Mica-peridotite from Kentucky: Am. Jour. Sci., 3d series, Vol. XLIV, Oct., 1892, p. 287.

[7] Waldemar Lindgren, On sodalite syenite and other rocks from Montana: Am. Jour. Sci., 3d series, Vol. XLV, Apr , 1893, p. 287.

[8] J. J. Harris Teall, British Petrography, 1888, p. 337.

[9] Alfred Harker, Bala Volcanic Series of Rocks, pp. 23, 53, 54.

[10] W. C. Brögger, Der Mineralien der Syenitpegmatitgänge der südnorwegischen Augit und Nephelinsyenit: Groth's Zeitschrift für Krystallographie, Vol. XVI, p. 46.

[11] Otto Nordenskjöld, Zur Kenntniss der sogen. Hälleflinta des nordöstlichen Smålands: Bull. Geol. Inst. Upsala, Vol. I, No. 1, 1893.

[12] A section of this felsite was loaned by Prof. L. V. Pirsson. It is of especial interest in its great similarity to the South Mountain felsite, thereby showing the southward persistence of this rock type.

[13] J. S. Diller, Felsites and assoc. rocks north of Boston: Proc. Boston Soc. Nat. Hist., Vol. XX Jan. 21, 1880, pp. 355–368: also Bull. Mus. Comp. Zool. Harvard Coll., wholê series, Vol. VII; geol., series, Vol. I. Thin sections of these felsites were kindly loaned by Mr. Diller to the Johns Hopkins laboratory. They have many microscopic features in common with the South Mountain rocks, and like them were first supposed to be of sedimentary origin.

[14] The writer's attention was called to the presence of this structure in the Minnesota acid volcanics by Dr. U. S. Grant, of the Minnesota State Geological Survey.

intergrowth, in most of the occurrences described these have been the component minerals. In the South Mountain rocks the feldspathic material is usually so abundant as not to admit of the determination of the mineral character of the host. In such cases a clue to the nature of the cementing material is found in its optical continuity with the porphyritic quartz. These phenocrysts are severally included within a single micropoikilitic area, with which they are always similarly oriented (Pl. XVII, *b*). The cementing material acts as a sort of secondary enlargement of the quartz phenocrysts. The feldspar phenocrysts, on the other hand, have no effect upon the orientation of the cement.

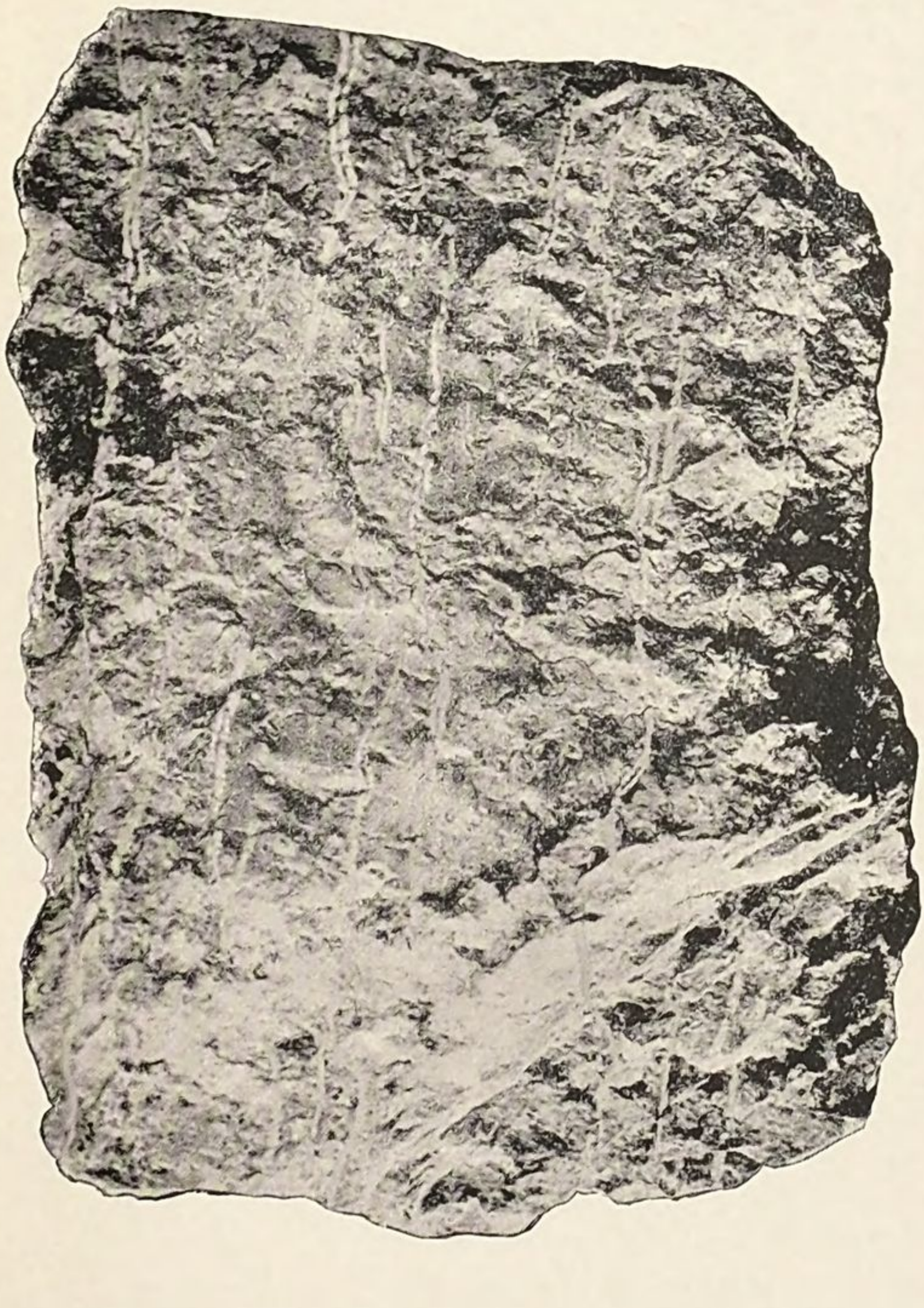
In the basic rocks, which are coarser-grained, the character of the host can be directly tested and proved to be quartz. The mottled appearance, previously alluded to, is usually emphasized by the arrangement of globulites, longulites, and trichites of iron oxide. This is such as both to accord with the flow structure and to outline the quartz areas, which in these cases have a somewhat oval shape.

When shearing has led to the production of sericite, this mineral is formed around the micropoikilitic areas, rarely traversing a single area, when it seems to be cementing material filling a crack (Pl. XVII, *b*). These areas are persistent, and slowly disappear in the development of a slate.

While in some cases this structure is undoubtedly of primary character, as Professor Iddings considers it to be in many porphyrites, in a large class of rocks its secondary origin seems equally certain. Irving, who gives one of the best as well as the earliest (1881) descriptions of this structure, considered it of a secondary character. His statements as to its nature and origin are so applicable to the South Mountain aporhyolites that they are quoted here in full:[1]

> Although wholly absent from some sections, a very highly characteristic feature of the sections of many of these rocks, and more particularly of the felsites without porphyritic quartz, is a network quartz which can only be regarded as of secondary origin. I find no mention of such a feature in any of the descriptions of the felsites of other regions which I have examined. Only occasionally * * * is this network quartz coarse enough to be readily seen with a low power in the ordinary light. Usually both a high power and the use of the polarized light are required for its detection, when it appears in its most characteristic development as a delicate aborescent tracery or frost-work saturating the ground mass in all directions.
>
> In the polarized light all of the quartz network within each of these numberless irregularly round areas, whose existence would not be suspected in the ordinary light, is found to be similarly oriented.
>
> From these more pronounced developments the secondary quartz is found through many degrees of lessening amount and less plainly marked character until it disappears altogether. It is plainly of the same nature as the secondary quartz of the already described orthoclase-gabbro, diabase-porphyrite, and quartzless porphyry, and of the augite-syenite described below. It never, however, reaches in the rocks now under description the coarseness nor presents the graphic forms with which it appears in the augite-syenites, its characteristic development here being the deli-

[1] Loc. cit., pp. 99–100.



APORHYOLITE WITH SPHERULITES IN LAYERS.

From Jim Saunder's farm, Bigham Copper mine district. Five-sevenths natural size. The details of the spherulitic chains are lost in the photograph.

cate arborescent clusters above mentioned. Whether this secondary quartz may ever be rather a result of devitrification than a truly secondary or alteration product, I have no means of deciding, though it is certainly the latter often, and I should suppose always.. It surely can have no connection with the original solidification of the rock.

Observations made on the South Mountain aporhyolites lead to essentially the same conclusions as those reached by Irving. As the nature of the structure is of both interest and importance in its bearing upon the question of the primary or secondary character of the groundmass, attention will be called to some of the observations which prove suggestive.

It has been stated that a few sections of the basic lavas of South Mountain exhibited this structure. In these sections the nature of the structure could be more readily detected. (Pl. XIX, *a* and *b*.)

The outline of the lath-shaped feldspars, forming an original ophitic structure, is completely preserved, though none of the original constituents of the rock remain, unless some of the titaniferous iron oxide is original.

At present the rock consists entirely of quartz, epidote, magnetite (or ilmenite), and leucoxene. It is amygdaloidal, and the vesicles are filled with secondary quartz. Quartz is also a cement for the minerals of the groundmass, and forms irregular interlocking areas, which are quite similar to the micropoikilitic areas of the finer-grained acid rocks, and produce in polarized light the familiar patchy effect. Fine cracks traversing the sections are still preserved in outline by the ferrite, but are prior to the quartz areas, which have obliterated all trace of cementing material. The epidote, which replaces crystals of some former ferromagnesian constituent, is often pierced by these cracks, which become invisible in the quartz areas save for the outlining ferrite. There can be no question as to the secondary character of the micropoikilitic structure in these cases.

Some structures described by Zirkel[1] in the rhyolites of the Washoe district are suggestive in this connection. He notes (slide 350, fig. 1, Pl. VI) perlitic parting in certain rhyolites (southeast from Wadsworth), where the cracks, semicircular and oval, traverse a glassy groundmass and are bordered by a narrow zone of microfelsite, "giving [to the section] the appearance of a network." The same general effect is produced in other rhyolites of the district (secs. 351, 352, figs. 2, 3, Pl. VI) by faint granular lines "which, by their fluidal running, form a net with a multitude of meshes of oval shape." These lines seemed to be the vestiges of perlitic cracks, though they could not be certainly determined as such. A widespread and characteristic type of rhyolite (secs. 333, 407, fig. 1, Pl. VIII) shows the same network of dark granular lines, but in this case the meshes are filled with a spherulitic crystallization.

There are, then, two types of crystallization which may occupy the

[1] Geol. Expl., 40th parallel, Vol. VI, Microscopic Petrography.

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oval spaces, the spherulitic and the microfelsitic. The former does so to the exclusion of a glassy groundmass, and must have been formed prior to the consolidation of the rock. The latter shares the space with the glass into which it gradually passes and of which it may be a molecular alteration. Turning to the South Mountain aporhyolites (particularly the spherutaxites), we find a similarity in the development of faint granular lines forming irregular oval meshes and giving to the section the network appearance figured by Zirkel. These lines may be traces of a former perlitic parting or of a microfluidal structure. The meshes are now filled either by the quartz areas which condition the micropoikilitic structure or by the vestiges of a spherulitic crystallization.

The latter represents a primary structure, as in the rhyolites; the former may represent the molecular rearrangement of a spherulitic crystallization or of a glassy groundmass. In the last case it is the direct result of devitrification and infiltration, processes more readily initiated along the borders of the perlitic cracks, as in the rhyolites of the Washoe district.

A comparative study of some sections[1] of the rhyolites of the Rosita Hills, Colorado, and of Obsidian Cliff, Yellowstone National Park, side by side with the aporhyolites under discussion, also suggests the secondary character of the micropoikilitic structure with reference to the spherulitic crystallization. In the trichitic spherulites of the modern rhyolites there is an appearance analogous to the micropoikilitic mottling, caused by the breaking up of the radiating spherulitic fibers into irregular areas which extinguish differently. An altogether similar phenomenon occurs in some of the spherulites of the ancient rhyolites. It is indicative of an intermediate stage between the spherulitic and a completely micropoikilitic crystallization. This change from the spherulitic to the micropoikilitic structure is carried still further in some sections, notably in the case of a specimen crowded with minute red spherulites. Each spherulite extinguishes as an individual filled with inclusions of feldspar and iron oxide (hematite). The host can be determined by optical tests to be quartz. The shape of the spherical bodies in the hand specimen and in thin section, their tendency to form bands and chains, and their uniform color put their original spherulitic character and the secondary nature of the micropoikilitic structure beyond doubt. It is not supposed that a prior spherulitic crystallization always existed where now the aporhyolites show a micropoilitic structure, but these evidences of the derivation of the structure from spherulites establish a presumption for its secondary origin in other aporhyolites, where it may be the direct result of devitrification or may be due to the subsequent alteration, by infiltration, of a granular crystallization.

On the whole, the plainly secondary character of the micropoikilitic

[1] Sections of material from these localities were kindly loaned the writer by Dr. Cross and Professor Iddings.

structure in the basic volcanic, the evidence in the aporhyolites of its being subsequent to fluidal lines or to perlitic parting, the indications that in many cases it is subsequent to a spherulitic crystallization, all denote a secondary origin for this structure in the South Mountain rocks.

Spherulitic structure.—There are two sorts of spherulitic crystallization in the aporhyolites. They differ in no essential respect, but are unlike in appearance. The most numerous spherulites are also the simplest and smallest. They are colorless, microscopic spheres, scarcely or not at all perceptible in ordinary light, but between crossed nicols showing a distinct dark cross. Spherulites in every respect similar have been described and figured by Professor Iddings from the rhyolites of the Yellowstone National Park.[1] Similar spherulites also occur in the rhyolites of Hungary and in the felsites of the Boston Basin. These radial growths are grouped in bunches and along lines, and are composed of positive fibers. Further optical determination of the fibers could not be made. Their positive character indicates either a prismatic section of quartz elongated in the direction of the vertical axis or a clinopinocoidal (010) section of orthoclase elongated in the same direction. In the latter case the extinction would be slightly inclined. This is impossible, however, of determination.

While it is not impossible that some of these spherulites are secondary, in some cases there is evidence of their primary character. One such case of spherulites whose formation was coincident with the consolidation of the rock occurs in an aporhyolite from a cut made by the Gettysburg Railroad north of Toms Creek trestle. Minute colorless spherulites are embedded in a base which suggests in every way its former glassy condition. In ordinary light there is no evidence of crystallization except the porphyritical.

The groundmass is traversed by irregular, angular cracks, evidently the result of crushing. These cracks, which are cemented by epidote, pass through the spherulitic aggregates (seen with crossed nicols), sometimes cutting directly across a spherulite, portions of which appear on either side of the crack. Between crossed nicols the field breaks up into a mosaic of quartz and feldspar. The granular crystallization disregards the cracks, filling the spaces left by the cementing epidote. It seems fair to conclude from these observations that the spherulitic crystallization is prior to the cracking, that the granular crystallization is subsequent, and that the cracking occurred in an already solidified glass.

The secondary character of the granular crystallization admitted, it is easy to suppose that it is due to devitrification continued through lapse of time. The spherulites, on the other hand, being prior to the crystallization of the groundmass, and prior to the cracking, are doubtless primary and contemporaneous with the consolidation of the glass.

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[1] Obsidian Cliff: Seventh Ann. Rept. U. S. Geol. Survey, Pl. XVII, p. 276.

The other class of spherulites correspond to those figured by Professor Iddings.[1] They are much larger than those that have just been described. The smallest is easily discernible by the naked eye, while the largest is 12½ cm. in diameter. They are spherical, hemispherical, cylindrical, fan-shaped, oval, or irregular in form. While they all possess a clear-cut, conspicuous outline in ordinary light, in many sections they completely disappear between crossed nicols. The fresh spherulites (Pl. XXII, *b*), which still show in polarized light a radiating structure, are usually colored red by a finely disseminated iron oxide. The globulites of hematite are distributed homogeneously throughout the spherulite, or they are grouped in radial and concentric lines. These lines are most dense near the margin of the spherulite, and may be separated from the central portion by a narrow clear zone, or it is the outer rim of the spherulite which is clear. In the central portion of the spherulite the coloring matter shows a tendency to collect in bunches that correspond with areas which extinguish as individuals. Between crossed nicols the field is broken up into the minute areas which were referred to on page 50 as forming a structure approaching the micropoikilitic. Feldspar phenocrysts usually occupy the center of the radiating crystallization, and two or more spherulitic centers may be included within a single outer zone. In specimens from Raccoon Creek[2] these radial growths were remarkably well preserved and occur in a groundmass which retains the characteristics of a glass in great perfection (Pl. XX, *a*; Pl. XXI, *a*). It bears a close resemblance to the groundmass of some of the Colorado rhyolites, and in ordinary light would certainly be mistaken for the base of a fresh glassy lava. Delicate perlitic parting, which because of its delicacy is easily obliterated, is here preserved in wonderful detail. It is evidently subsequent to the radial crystallization to which it accommodates itself. The presence of innumerable globulites accentuates the perlitic and rhyolitic structures. With crossed nicols the groundmass at once betrays its holocrystalline character (Pl. XX, *b*). All glassy structures disappear, to be replaced by granular quartz and feldspar, a crystallization which closes the perlitic parting and thereby completely obliterates it.

The porphyritic feldspars still show inclusions of a glassy base. It is impossible by any description to produce that definiteness of conviction as to the original glassy nature of the groundmass which the character of the sections justifies. To one who has studied these sections in both ordinary and polarized light there can be no question as to the secondary character of the holocrystalline groundmass. One can not escape the conviction that the rock originally consolidated as a spherulitic perlite and has become holocrystalline by a process of devitrification.

The sequence of events, as revealed by microscopic study, is as follows: There was first the intratelluric development of the porphyritic

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[1] Op. cit., p. 277, Pl. XVII.

[2] In Franklin County, Pa., east of Rocky Ridge and south of Graeffenburg.

crystals, followed by the emergence of the magma, the development of globulites and fluxion structure, the commencement of radial crystallization, and finally the consolidation of the magma as a glass and the development of perlitic parting. Subsequent to all this, and extending over a much longer period of time, the process of devitrification took place.

Associated with a holocrystalline groundmass, which bears less marked evidence of an original glassy character, are the more altered spherulites. Their circular outline in the thin section and their spherical shape in the hand specimen testify to their former presence.

In both hand specimen and thin section a threefold zonal arrangement is often clearly defined by the distribution of red or black iron oxide. With crossed nicols these boundaries become inconspicuous, and the field of the microscope shows only a uniform quartz-feldspar mosaic, or the former radial growth is indicated by zones of a finer-grained crystallization than the groundmass (Pl. XXIII, *a*), or a micropoikilitic structure is present within the spherulitic boundaries when absent in the groundmass. Occasionally, vestiges of a radiate structure still remain.

In the specimen already referred to on page 50 and figured in Pl. XXII, *a*, the spherulites are colored red by a uniform dissemination of hematite particles, and are not more than one-half mm. in diameter. They traverse the rock in rows and chains, which are in turn grouped in bands about 2 inches wide. The rock has been sheared, a ready cleavage has been produced, and sericite has developed around each spherulite. As has already been mentioned, the spherulitic individuals have become micropoikilitic individuals. Another specimen shows spherulites which have been rendered almond-shaped through shearing or, less probably, by the fluidal movement of the magma during this consolidation. That the former was probably the case is indicated by the gradual passage of the rock into a slate and the development of biotite.

Spherulites which, like these, have been replaced by a fine-grained mosaic of quartz and feldspar have been described by Klockmann.[1]

Chain spherulites.—The arrangement of spherulites in layers and along planes so that a cross-section shows a chain of spherulites has been described on page 43 and figured on Pl. XVIII, *b*, as it appears in the hand specimen. In ordinary light the microscope discloses somewhat sinuous or straight dark bands, with scalloped borders sharply outlined, inclosing an irregular clear chain which also has scalloped edges.

Frequently there are detached clear spots with circular outline. These bands sometimes spread out so as to include phenocrysts and sometimes curve around them. (Pl. XVIII, *b*.) A comparative study of these spherulitic chains and the chains of fresh spherulite of the Yel-

[1] Die Porphyre; Der geologische Aufbau des sogen. Magdeburger Uferrandes mit besonderer Berücksichtigung der auftretenden Eruptivgesteine: Jahrbuch K. preuss. geol. Landesanstalt, Vol. XI, 1890, p. 179.

lowstone obsidians discloses a striking similarity in ordinary light—the same irregularly scalloped outline, the same central chain of clear spherules. With crossed nicols the close similarity vanishes, for in the ancient rocks the radial growth has utterly disappeared. The central clear chain consists now of a fine quartz mosaic. The dark borders, except for the crowded magnetite globulites, can not be distinguished from the holocrystalline quartz-feldspar groundmass. This clear central zone where the spherulites converged evidently furnished the plane of weakness and easy solution, along which silica was infiltrated and parallel to which the rock cleaves.

The impurities which have entered the rock along this cleavage plane give rise to the central dark line mentioned in the macroscopic description, while the silica forms the opaque white band on either side. The central zone is sometimes more than a millimeter wide. Where a feldspar crystal lies across this plane of weakness with its longest axis at right angles to the latter, the strain has proved too great for the crystal, which has been broken apart and the break cemented by infiltrated silica (Pl. XXIII, *b*).

The chain spherulite structure is of more common occurrence in the aporhyolites of the Monterey district than any other form of spherulitic growth. The acid rocks east of the Bigham copper mine show them in great perfection. Rutley[1] has figured some similar chain spherulites in the felsitic lavas of England and Wales. In felsite of the Keweenaw series from the Minnesota shore of Lake Superior the writer has recently observed fine bands of silica so similar to the altered chain spherulites as to suggest a like explanation for them.

Axiolitic structure.—Closely related genetically to the chain spherulites, but unlike them in being radial linearly rather than centrally, is the axiolitic growth.[2]

Axiolites are not particularly characteristic of the South Mountain aporphyolites. Curving, linearly radiating growths do occur, however, in specimens from more than one locality. Pl. XXI, *b*, shows this structure.

Rhyolitic structure.—The rocks in which the axiolites were observed are holocrystalline, yet they exhibit most strikingly the characteristics of a glass. Flow and vesicular structures, stringers and shreds, and curved patches of a brownish-red color, forming what has been called the rhyolitic structure, abound. (Pl. XXIV, *a* and *b;* Pl. XXV, *a*.) This latter structure has been figured and described by Rutley,[3] Nordenskjöld,[4] and de la Vallée-Poussin,[5] and on a macroscopic scale by

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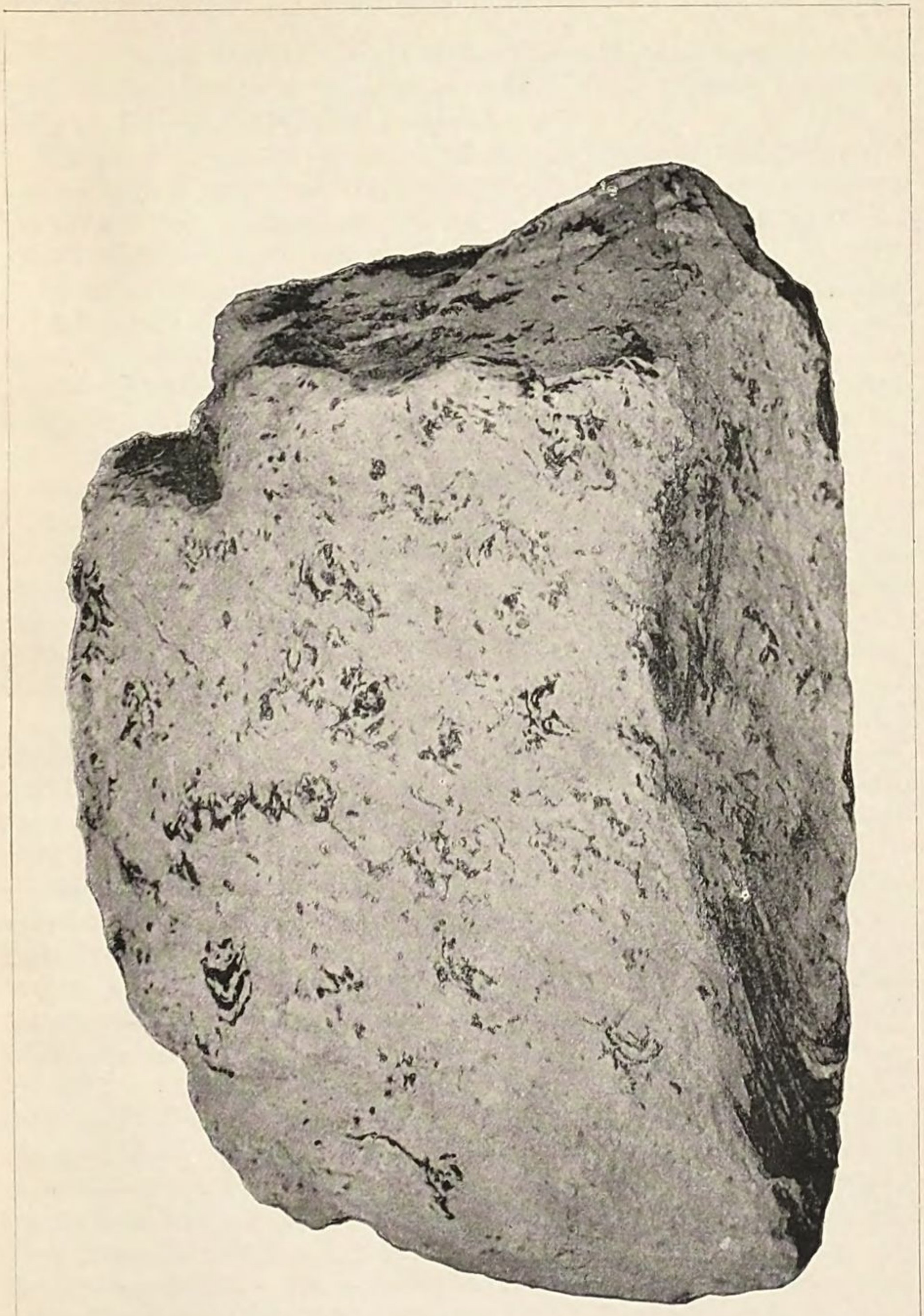
[1] Felsitic lavas of England and Wales: Mem. Geol. Survey, Gt. Brit., 1885, Pl. VII, figs. 11 and 12.

[2] Zirkel, Microscopic Petrography: Geol. Expl. 40th parallel, p. 167.

[3] Rutley, On the microscopic structure of devitrified rocks from Beddgelert and Snowden: Quart. Jour. Geol. Soc. London, Vol. XXXVII, p. 406, figs. 1 and 2.

[4] Nordenskjöld, Zur Kenntniss des sogen. Hälleflinta des nordöstlichen Smålands: Bull. Geol. Inst. Upsala, No. 1, Vol. I, p. 5, 1893.

[5] De la Vallée-Poussin, Les anciennes rhyolites, dites eurites, de Grand-Manil: Bull. Acad. Roy. Belgique, 3d series, Vol. X, 1885, p. 271.



LITHOPHYSÆ, RACCOON CREEK.

The rock is a pale pink, while the originally hollow spaces between the concentric layers of the lithophysæ are filled with a deeper pink siliceous deposit.

Irving.[1] A perlite from Deer Creek Meadows, 25 miles south of Lassen Peak, displays a similar rhyolitic structure. This structure is essentially a phase of the fluidal structure.[2]

Lithophysal structure.—Very often the macroscopic features of the aporhyolites disclose their original character more convincingly than do the microscopic. Lithophysæ are best revealed in the hand specimen, where they are brought out in delicate relief by weathering. In such specimens from the Raccoon Creek locality, the rose-pink petals of the lithophysæ in a pale-pink base produce quite as beautiful examples of this glassy structure as any obsidian or rhyolite offers. (Pl. XI.) No undoubted lithophysæ were found within the Monterey district. The microscope discloses some vesicular structures which bear slight trace of a lithophysal character, but the alteration has been too great to allow of their identification as hollow spherulites.

Micropegmatitic structure.—The micropegmatitic structure shows itself in microscopic pegmatoid groups of phenocrysts, such as have been frequently described in porphyries and rhyolites.[3] It does not play an important part in the aporhyolites.

Perlitic structure.—That this structure is present in the South Mountain rocks, and in great perfection, has already been noted. (Pl. XX, *a*, Pl. XXI, *a*.) While its presence is a most reliable proof of the former character of the rock, its absence furnishes no evidence against the previous glassy condition of the rock, both because many recent rhyolites showed no trace of that structure and because it is most readily effaced by devitrification.

Amygdaloidal structure.—At Raccoon Creek, at the Bigham copper mine and its near vicinity, are light-colored (pink and yellow), extremely vesicular aporhyolites. The vesicles are oval or elongated by flow movement. (Pl. XXVI, *a* and *b*.) They are uniformly filled with epidote or quartz, with both, or with either to the exclusion of the other. When both are present the quartz forms a rim around the epidote. The epidote has often a radial arrangement, while crystal boundaries are absent. Its color varies from a deep yellowish green to light yellow, and pleochroism is marked. In some of the larger amygdules the radiating needles of epidote have been broken and pulled apart at right angles to their longer axis and the spaces filled with silica. Piedmontite and quartz show the same relation, as described on page 41. The groundwork of these amygdaloids is the usual holocrystalline quartz-feldspar aggregate. Incipient alteration to granular epidote is more frequent in these open-textured amygdaloids than in the compact aporhyolites. These

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[1] Irving, Copper-bearing rocks, etc.: Mon. U. S. Geol. Survey, Vol. V, pp. 312–313, fig. 22.

[2] This is the "Aschenstructur" of Mügge (Untersuchungen über die "Lenneporphyre" in Westfalen und den angrenzenden Gebieten: Neues Jahrb. für Min., Geol. u. Pal., B. B. VIII, 1893, pp. 648, 649, 713), who considers it due to the original fragmental character of the lava. Whether it is always to be so interpreted is a question for further investigation.

[3] Iddings, op. cit., p. 275, Pl. XV, fig. 5.

rocks are pierced with coarse quartz veins which bear native copper. Copper in microscopic quantities and copper oxide also occur in the amygdules. Hand specimens are frequently coated with the copper carbonates, malachite and azurite. There were picked up on the roadside some specimens of amygdaloidal aporhyolites that are quite diverse from the amygdaloids of the Bigham copper mine which have just been described. They are similar to specimens found north of the Monterey district at Raccoon Creek. The amygdules, which are black against a yellowish-white background, are finely attenuated and elongated in long parallel hair lines, lending to the rock the appearance of an eutaxite. The black color is due to magnetite, which either is finely disseminated in quartz (the other infiltrated mineral), or is present in masses, or simply forms a heavy rim around the amygdules.

Some of the amygdaloids from Raccoon Creek merit a detailed description. In these rocks the vesicles are usually bordered by a broad rim like the groundmass, in its present crystallization, but separated from it by a narrow, clear zone of quartz, and characterized by a greater abundance of magnetite (or ilmenite). On the inner edge of this border are spherulitic growths, while the rest of the vesicle is filled with quartz (Pl. XXVII, *b*) or with quartz and an opaque black oxide (Pl. XXVII, *a*). In the latter case the black oxide occupies the center of the vesicle, leaving a clear zone of silica around the spherulites. Crossed nicols show that the spherulites are optically continuous with the quartz, and that the radial appearance which has been retained is due to the arrangement of the impurities. The appearance of these vesicles is very suggestive of those figured by Professor Cole.[1] Professor Cole explains this type of spherulite by a dual mode of growth—a radial growth outward from the groundmass, as well as inward, originating in the glass and converging toward a spherulitic center! He does not give the mineral character of the spherulite. Whatever may be the facts with reference to the Rocche Rosse obsidian, it is not necessary to postulate an abnormal method of crystallization to explain the phenomena observed in the South Mountain aporhyolites.

The spherulites projecting into the vesicle, with their bases sunk into its walls, were recognized by Professor Iddings, who kindly examined the section, as tridymite spherulites, such as form on the walls of vesicular cavities in all kinds of modern lavas. Tangential sections of such spherulites are represented by granular aggregations. The form of the tridymite has been preserved by impurities, while its molecular arrangement has been altered to that of quartz. The presence of a border between the groundmass and the cavity suggests that crystallization, starting from the walls of the cavity, took place within the magma, initated, perhaps, by the gaseous content of the vesicle.

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[1]Grenville A. J. Cole and Gerard W. Butler, On the lithophyses in the obsidian of the Rocche Rosse, Lipari: Quart. Jour. Geol. Soc. London, Vol. XLVIII, 1892, p. 438.

Somewhat similar radial growths within vesicles in ancient rhyolites have been described and figured by de la Vallée-Poussin.[1]

Taxitic structure.—Another structure which the South Mountain rocks possess in common with rhyolites is what has been called the taxitic.[2] This consists in the intimate mingling of two portions of the magma which from some cause (liquation) are slightly differentiated. The iron constituent, which evidently separated out in the original glass, has been still further crowded into bands and curved lines by the secondary crystallization. The result is the production, in some cases, of an irregular mottling, when the rock is called an *ataxite;* and in other cases of a more or less complex network of interlacing bands following lines of flow and forming a *eutaxite.* This mottling and banding is made the more striking by a marked contrast in color. The body of the rock is light-gray or pink, and the lines are dark blue-gray or red, according to the varying degrees of oxidation of the iron. Where the dark lines outline oval and spherical spaces and contain porphyritical crystals in or near their centers, the crystallization is regarded as having once been spherulitic and the rock is termed a *spherutaxite.* These have been described on page 50.

The eutaxites are frequently so sheared as to give a hair-like tenuity to the bands in cross section, while the microscopic slide shows the effect of pressure on the rock in the parallel arrangement of the globulites of black oxide. The universal presence of globulites, trichites, and microlites of black and red iron oxide in flow bands, or indifferently distributed, or in concentric zones around spherulites and vesicles, is worthy of mention as a further point of resemblance to the modern rhyolite. Such a *trichitic structure* in similar rocks has been described by various petrographers.[3]

SUMMARY OF PROOF OF DEVITRIFICATION.

It is not easy to present the evidence for the secondary nature of the holocrystalline groundmass so that it shall have the weight which properly belongs to it. Very much depends upon effects which it is impossible to convey by description, but which carry conviction to the student of these rocks. The contrasting appearance of many of the sections in ordinary and polarized light can not be adequately reproduced. The disappearance under crossed nicols of rhyolitic, perlitic,

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[1]Les anciennes rhyolites, dites eurites, de Grand-Manil: Bull. Acad. roy. Belgique, 3d series, Vol. X, 1885, p. 292.

[2]Fritsch and Reiss, Teneriffe, 1868, p. 414.

Rosenbusch, Mic. Phys. der Massigen Gesteine, 2d ed., p. 625.

F. Loewinson-Lessing, Zur Bildungsweise und Classification der klastischen Gesteine, 1888, pp. 228–235. Note sur les taxites et sur les roches clastique vulcanique: Bull. Soc. Belg. géol., etc., Vol. V., 1891. Loewinson-Lessing's division of the taxites into ataxites, eutaxites, and spherutaxites has been followed in this bulletin.

[3]R. D. Irving, Copper bearing Rocks, etc.: Mon. U. S. Geol. Survey, Vol. V, p. 312.

S. Allport, On certain ancient devitrified pitchstones and perlites from the Lower Silurian district of Shropshire. Quart. Jour. Geol. Soc. London, Vol. XXXIII, p. 449.

Nordenskjöld, op. cit.

spherulitic, and fluxion structures, so clearly indicated in ordinary light, in a homogeneous holocrystalline mosaic is one of the strongest evidences for the secondary character of the crystallization.

There are also instances where the nature of the crystallization is distinctly proved. On page 51 it was shown to be subsequent to the cracking which must have occurred in a solid rock. Pages 52–53 describe the replacement of the radiating crystallization of the spherulites and chain spherulites by a granular crystallization which is homogeneous with a granular groundmass. Finally, on pages 49–50, the secondary character of the micropoikilitic crystallization has been indicated. One or another of these indications of secondary crystallization is almost invariably present in the rocks which have been included under the name aporhyolite.

The exceptional occurrences, where these structures are absent, show genetic relationship in the field to typical aporhyolites. The determination of the character of the groundmass in the cases described thus practically determines it for all the aporhyolites.

The secondary character of the holocrystalline groundmass once admitted, and the indications of an original glassy base recognized as such, one is forced to conclude that the former was developed from the latter by a process of devitrification.

That the processes of crystallization do not necessarily cease with the solidification of a magma is well known, for experiment has proved that crystallizing forces are active in a glass as well as in a molten magma.[1] This action is exceedingly sluggish, and requires, unless accelerated by heat and moisture, an immense amount of time. Devitrification has been considered the result of dynamic action only;[2] but while dynamic action undoubtedly accelerates the process, if it does not initiate it, devitrification may also take place independently of dynamic action, as was the case in the famous example of the old cathedral window glass[3] and the ancient devitrified glass from Nineveh investigated by Sir David Brewster.[4] The nature of the process is in no way different from the process of crystallization in a fluid magma save in the rapidity of the action, and is of both a physical and a chemical character.

The devitrification which has occurred in the South Mountain aporhyolites is not attributed to dynamic action, of which there are many evidences of another nature in the South Mountain, but to statical metamorphism. The former would, by shearing, obliterate the original structures of a glassy rock and produce a slate, while the latter might be an important initiatory and accelerating factor in the process of devitrification of the glassy rocks.

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[1] Daubrée, Géologie expérimentale, 1879, p. 158.

[2] De la Vallée Poussin, Les eurites quartzeuses (rhyolites anciennes) de Nivelles et des environs: Bull. Acad. roy. sci. lett. et des beaux arts de Belgique, 57 année, 3d series, Vol. XIII, No. 5, 1887, pp. 521–522. T. G. Bornemann, Der Quartzporphyr von Heiligenstein und seine Fluidalstructur: Zeitschr. Deutsch. geol. Gesell., Vol. XXXIX, 1887, p. 793.

[3] British Ass. Rept., 1840.

[4] Trans. Royal Soc. Edinburgh, Vols. XXXII, XXXIII.

Opinions of petrographers.—Paleozoic and pre-Paleozoic acid volcanics have long been studied on the European continent. Although their variation from the modern type of acid volcanics, rather than their resemblance to that type, has, for the most part, been emphasized by German and French petrographers, there have not been wanting able advocates of devitrification and of an original glassy base for the ancient lavas.

R. Ludwig[1] (1861) and Vogelsang[2] (1867) inclined to the opinion that the groundmass of certain quartz-porphyries is the result of the devitrification of a glassy lava.

The late Dr. K. S. Lossen[3] (1869), on comparing the spherulitic porphyries of the Harz Mountains with the obsidians of Lipari, Mexico, and Java, found the resemblance sufficiently striking to lead him to declare that the porphyry groundmass was originally crystallized as glass, and became cryptocrystalline through molecular rearrangement. Later, Kalkowsky[4] (1874) suggested that devitrification through the chemical activity of water was the process by which the microfelsitic base of certain pitchstones and felsites was developed; and still later, H. Otto Lang[5] (1877) described a macroscopically unindividualized base which is similar macroscopically to the devitrified base described by Kalkowsky. Sauer[6] (1889) considered the Dobritz porphyries as the final alteration product of a pitchstone. More recently Klockmann[7] (1890) has described the replacement of the spherulitic crystallization in quartz porphyries, through secondary processes, by a fine-grained aggregate of quartz and feldspar.

Osann[8] (1891) described incipient devitrification in perlite and other glassy rocks from Cabo de Gata. Finally, Link (1892) considered that the fine-grained groundmass of some American rocks closely related to mica-syenite-porphyries was once glassy, or at least partially glassy, and C. Vogel[9] (1892) reached the same conclusion as to the Umstädt porphyries in Hessen. Many no less capable observers still hold to an original difference between ancient and recent acid volcanics, and the possibility of devitrification and an original similarity is yet an open question in Germany.

In France, La Croix[10] describes andesites from Martinique in which the glass has altered into quartz spherulites and a granular quartz aggregate.

It is interesting to note that many of the hälleflinta of Sweden,

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[1] Erl. zur geol. Karte Hessens, Bl. Dieburg, 1861, p. 56.

[2] Phil. de géologie, pp. 144, 153, 194.

[3] Beiträge zur Petrographie der plutonischen Gesteine: Abhandl. der Berliner Acad., 1869, p. 85.

[4] Tschermaks mineral. Mittheil, pp. 31, 58.

[5] Grundriss der Gesteinskunde, p. 43.

[6] Erl. zur geol. Specialkarte Sachsens. Bl. Meissen, pp. 81-91.

[7] Die Porphyre; Der geol. Aufbau sogen. Magdeburger Uferrandes mit besonderer Berücksichtigung der auftretenden Eruptivgesteine: Jahrbuch K., preuss. geol. Landesanstalt, Vol. XI.

[8] Zeitschr. Deutsch. geol. Gesell., Berlin, pp. 691, 716.

[9] Abhandl. geol. Landesanstalt von Hessen, Vol. II, p. 38.

[10] Comptes-rendus, CXI, p. 71.

which, like the South Mountain volcanics, were once described as sedimentary, are proving to be acid volcanics, preserving the features of their modern equivalents. Quite recently glassy and rhyolitic structures in these rocks have been observed and described by Otto Nordenskjöld.[1]

In Belgium, de la Vallée-Poussin seems to be the only writer who has brought out the resemblance between the eurites of that country and modern rhyolites. He describes at some length structures similar to those possessed by the aporhyolites of South Mountain. A vacillating state of mind as to the matter of nomenclature is indicated in the titles of his successive papers.[2]

In England the rhyolitic character of ancient acid volcanics has been recognized and emphasized, and the idea of devitrification is widely accepted. Allport, Cole, Bonney, Rutley, Judd, and Harker have accomplished most valuable work along this line.

Dr. Wadsworth [3] was the first American petrographer to advocate the abandonment of age as a factor in rock classification, while at the same time he recognized devitrification as the process which was forming felsites out of rhyolites. What he says is of interest in its anticipation of ideas now more generally accepted:

> This devitrification gives rise in the older and more altered rhyolites to the feldspar, quartz, and microfelsitic (so called) base that has so puzzled lithologists in the study of the felsites. The rhyolites of all volcanic rocks preeminently show lamination produced by flowing, a fact which is doubtless due to their being so siliceous. This structure and their devitrification enable us to trace a direct connection between the rhyolites and felsites, which are simply the older and more altered rhyolites. * * * One of the best illustrations of this is to be found on Marblehead Neck, Massachusetts, where at least two distinct flows of felsite occur, one cutting the other. They show the fluidal structure so characteristic of rhyolites—a character that has been mistaken for lines of sedimentation by geologists, while the inclosed crystals of orthoclase have been taken for pebbles. * * * While to the naked eye and under the microscope this rock shows the fluidal structure of a rhyolite, in polarized light it is seen that the base has been completely devitrified, a process that is carried to a great extent in many known modern rhyolites.

No other American petrographer has so distinctly advocated the identity of felsites and ancient rhyolites, in spite of the fact that many of our felsites illustrate it as unmistakably as do the English felsites.

Dr. Irving,[4] in his description of the Beaver Bay group of the Keweenaw series, repeatedly calls attention to the resemblance between the ancient felsites and quartz-porphyries and the modern rhyolites, though he does not express an opinion as to their equivalence.

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[1] Op. cit. Also Ueber archæische Ergussgesteine aus Småland: Bull. Geol. Inst. Upsala, No. 2, Vol I, 1893, pp. 1-127.

[2] Les anciennes rhyolites, dites eurites, du Grand-Manil: Bull. Acad. roy. Belgique, 3d series, Vol. X, 1885, pp. 253-315. Les eurites quartzeuses (rhyolites anciennes) de Nivelles et des environs: Bull. Acad. roy. des sci. et des beaux-arts de Belgique, 57 année, 3d series, Vol. XIII, No. 5, 1887.

[3] M. E. Wadsworth, Notes on the mineralogy and petrography of Boston and vicinity: Proc Boston Soc. Nat. Hist., Vol. XIX (May, 1877), p. 236. On the classification of rocks: Bull. Mass. Comp. Zool. Harvard Coll., Vol. V, No. 13, June, 1879, p. 277.

[4] Op. cit., pp. 312, 313, note 5, p. 436.

Messrs. Hague and Iddings[1] make the statement "that the degree of crystallization developed in igneous rocks is mainly dependent upon the conditions of heat and pressure under which the mass has cooled, and is independent of geological time."

On the question of devitrification the writer finds no more direct expression of opinion, but the fact of devitrification is recognized by Iddings, Williams, Cross, and Diller. In none of the felsites elsewhere described have the varied structures of the modern rhyolites been more perfectly and conspicuously preserved than in the aporhyolites of the South Mountain.

CHEMICAL COMPOSITION OF THE ACID ERUPTIVES.

The chemical study of the South Mountain rocks has been rendered easy by a number of analyses of these rocks made by the late Dr. Genth, under the auspices of the Second Geological Survey of Pennsylvania. Analyses of the sedimentary, acid, and basic igneous rocks of South Mountain are distributed through pages 252 to 282 of Report CCC.

The analyses of the acid volcanics have here been brought together and tabulated.

Table of analyses.

	I.	II.	III.	IV.	V.	VI.
SiO_2	79.970	79.920	76.76	76.62	75.570	75.31
P_2O_5	.....	.190	.11	.....	.190	.05
Al_2O_3	13.860	12.400	12.64	12.26	11.940	12.96
Fe_2O_3	.....	2.950	2.63	2.08	3.830	3.05
FeO	2.700	.....	.....	4.03	.....	.....
TiO_2	.....	.....	.68	.....	.....	.41
MgO	1.230	.....	.....	.26	.....	.....
CaO	.220	Trace.	.11	.34	.....	.....
K_2O	.....	6.490	6.15	2.57	5.250	3.15
Na_2O	.....	2.320	.....	.....	3.010	5.11
H_2O	.....	.....	1.53	.....	.....	.....
Ignition	.....	.440	.....	.40	.270	.61
Total	95.038	100.71	100.77	99.09	100.06	100.65

I. Fissile green schist. Between Pine Grove Furnace and Laurel forge.[2]

II. "Orthofelsite." "One-fourth of a mile north of Lerew's store."[3]

III. "Orthofelsite." "Cut on turnpike 5 miles northwest of Petersburg, Cumberland County."[3]

IV. "Laminated felsite." "East of Bigham Copper Mine."[4]

V. "Laminated orthofelsite." "One-fourth of a mile southeast of Caledonia Furnace."[3]

VI. "Finely laminated orthofelsite." "One-fourth of a mile west of Cole's sawmill, on the Shippenburg road."[3]

Their general uniformity and their close agreement with the analyses of typical rhyolitic lavas is the most striking feature of these analy-

[1] On the development of crystallization in the igneous rocks of Washoe, Nev., with notes on the geology of the district: Bull. U. S. Geol. Survey No. 17, 1885, p. 40.

[2] Analysis made by A. S. McCreath for commercial purposes; alkalies undetermined.

[3] Analyses made by Dr. Genth and Henry Trimble, Second Geol. Surv. Pa., Vol. CCC, pp. 263–269.

[4] Analysis made by C. Hanford Henderson, of Philadelphia, The copper deposits of the South Mountain: Trans. Am. Inst. Min. Eng., Vol. XII, 1884, p. 90.

ses, and is a convincing proof of the igneous origin of the rocks which they represent. In the absence of samples of the rocks analyzed or of exact descriptions of their character, special points can be brought out only inferentially.

The high percentage of the alkalies and the slight trace of lime plainly denote the character of the feldspathic constituents. This indication of their chemical character coincides with the optical and physical properties enumerated on page 40. The rock from which Analysis IV was made is reported to be from the same locality from which many of the aporhyolites were obtained, the optical character of whose feldspars were tested.

Microscopic study of these rocks leads us to expect a percentage of titanium oxide. In two instances the analyses show it. It is not unlikely that in the other cases the titanium oxide was not determined. The absence of manganese oxide from these analyses is surprising, as the Monterey porphyries and aporhyolites show a high percentage of it. The lime and magnesia present are doubtless due to the presence of epidote in the rock. The silica, alumina, and iron percentages are exactly normal and call for no remark.

Analysis I, of a fissile schist, illustrates the slight change of chemical constitution which accompanies dynamic action in the acid rocks.

Among the analyses made by Dr. Genth for the Second Geological Survey of Pennsylvania are the following, which, because of their anomalous character, have not been tabulated with the others:

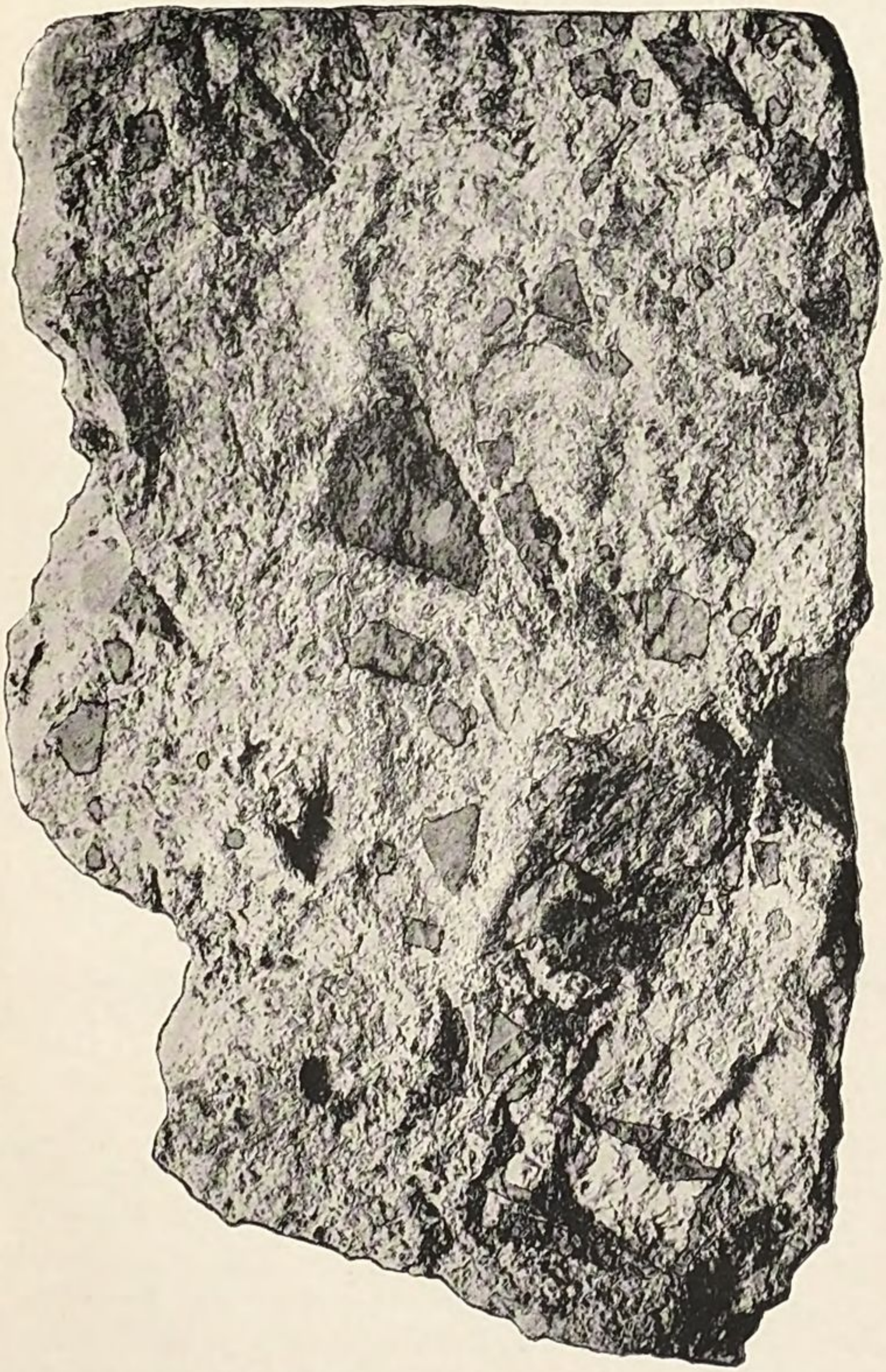
	I.	II.
SiO_2	53.86	52.82
P_2O_5	.....	.21
Al_2O_3	22.18	20.73
Fe_2O_3	7.11	.....
FeO	1.46	10.72
TiO_2	.....	1.92
MnO	.....	.52
MgO	2.79	2.03
CaO	1.99	.23
K_2O	4.56	6.68
Na_2O	4.12	.....
Ignition	2.55	4.28
Total	100.42	99.62

I. "Slaty rock." "Nine miles southwest of Dillersburg."

II. "Purplish slaty orthofelsite." "One and one-half miles southeast of Mount Alto."

These rocks plainly do not represent the normal type of the South Mountain acid rock. In the absence of specimens or means of determining the character of the rocks from which these analyses were made, it is impossible to explain altogether satisfactorily the abnormally low percentage of silica and the high percentages of alumina and iron.

If these slates were once normal aporhyolites, the shearing which produced the subsequent slaty character must have been accompanied by an abundant development of sericite from the feldspar. If the silica



FLOW BRECCIA.

From crest of hill east of the Clermont House. One-half natural size. The details of the brecciated structure are greatly obscured in the photograph. Some of the fragments are spherulitic; many of them fit together, forming what was once a large fragment. The colors are shades of pink, red, and purple.

thus set free was carried off by percolating water, a low silica percentage and a correspondingly high alumina percentage would result, while the alkalies would remain about the same. The increase in iron may be due to infiltration.

ACID VOLCANIC BRECCIA.

DISTRIBUTION.

The presence of acid pyroclastics in the Monterey district has already been mentioned. Although a conspicuous feature of a portion of South Mountain, notably of the Buchanan Valley north of the Chambersburg turnpike, where they cover about 2 square miles, they play an insignificant rôle among the rocks of the Monterey district. Their character, however, is unmistakable. They may be classified as tuffs, flow breccia, and true breccia or tuffaceous breccia.

TUFF.

This is a dark-purple banded rock, the clastic character of which is hardly evident in the hand specimen. Microscopic examination discloses its tuffaceous nature. Minute angular fragments, not exceeding a millimeter in length, are thickly distributed through a crystalline groundmass.

The fragments are usually spherulitic, with the replacement of the spherulitic crystallization, as in the massive aporhyolites described on page 52, by a fine mosaic, so that in ordinary light the spherulites are traceable only from their outline. In the same way, under crossed nicols a uniform granular crystallization obscures the fragmental character of the rock—a character which, in ordinary light, is sharply brought out by an outlining pigment of red iron oxide. Fragments of quartz and feldspar are among the inclusions. The groundmass, which is of the same chemical and mineralogical constitution as the included fragments, doubtless represents an ash recrystallized.

FLOW BRECCIAS.

These occur at widely separated localities—northwest of Old Maria furnace, near the source of Toms Creek, on the Gladhills road, and on the brow of the hill east of the Clermont House. These breccias are composed of fragments of considerable size, which plainly were caught in a viscous acid magma, as is evidenced by their linear arrangement in flow lines and by the way in which different fragments fit together, forming what was once a larger fragment. On the weathered surface of the rock its brecciated character is rendered very manifest in the varying tints of pink, red, purple, and blue (Pl. XII). The fragments range in size from the submacroscopic to those that are $2\frac{1}{2}$ inches in diameter. Their spherulitic character is discernible by the naked eye. Under the microscope, in ordinary light, the fragments frequently show either perlitic parting, a spherulitic character, or a regular arrangement

of the coloring matter parallel to the boundaries of the fragments, due to water deposition. Crossed nicols again show uniform crystallization or a micropoikilitic structure. In one specimen of breccia this was not the case, however. A coarsely crystalline siliceous cement is quite distinct in grain from the uniformly finely crystalline fragments. This may be a lava flow crushed and recemented.

TUFFACEOUS BRECCIA.

In some instances the groundmass doubtless represents an altered ash, when the rock becomes a true breccia. A breccia of this sort from the Monterey district has epidote largely developed in the matrix. The granulated quartzes and the perthitic feldspars of the included fragments show in a marked way the effect of dynamic action.

At Raccoon Creek a fine specimen of breccia was found (Pl. XIII), and in the Buchanan Valley breccia is extensively exposed. Some of the fragments contain chain spherulites. At Coles Corner (Buchanan Valley), some 6 miles northeast of Graeffenburg, the breccia is sheared, and with the development of sericite the rock has become more or less slaty, while still conspicuously retaining its brecciated character.

The presence of these tuffs, flow breccias, and breccias proper, which are the natural accompaniments of surface lava flows, is inexplicable under any other hypothesis of the origin of the acid rocks.

METAMORPHOSED ACID ERUPTIVES: SERICITE-SCHISTS AND SLATES.

The alteration of the feldspathic constituent of quartz-porphyries to sericite or some other micaceous mineral, under the action of dynamic forces, has been frequently described.[1]

The production, in this way, from massive acid eruptives, of schists and slates resembling true porphyroids,[2] is finely illustrated in the South Mountain. In a single exposure (west end of Long Mountain, west of Gettysburg) felsites with distinct phenocrysts grade insensibly into a crinkled sericite slate. The shear zone is of limited width (10 feet), and bounded on each side by massive felsites. The phenocrysts are only slowly obliterated and can be distinguished until the last stage in the alteration has been reached.

Thin sections of five successive stages were studied. They show a development of sericite first around the feldspar phenocrysts and in a plane of dislocation. It is only sparingly developed in the ground-

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[1] J. Lehmann, Untersuchungen über die Entstehung der altkrystallinischen Schiefergesteine, Bonn, 1884, Cap. IX, Druckschieferung und Glimmerbildung, p. 136.

A. von Groddeck, Zur Kenntniss einiger Sericitgesteine, welche neben und in Erzlangerstätten auftreten: Neues Jahrbuch für Mineral., etc. Supp. Vol. IV, 1886, p. 428.

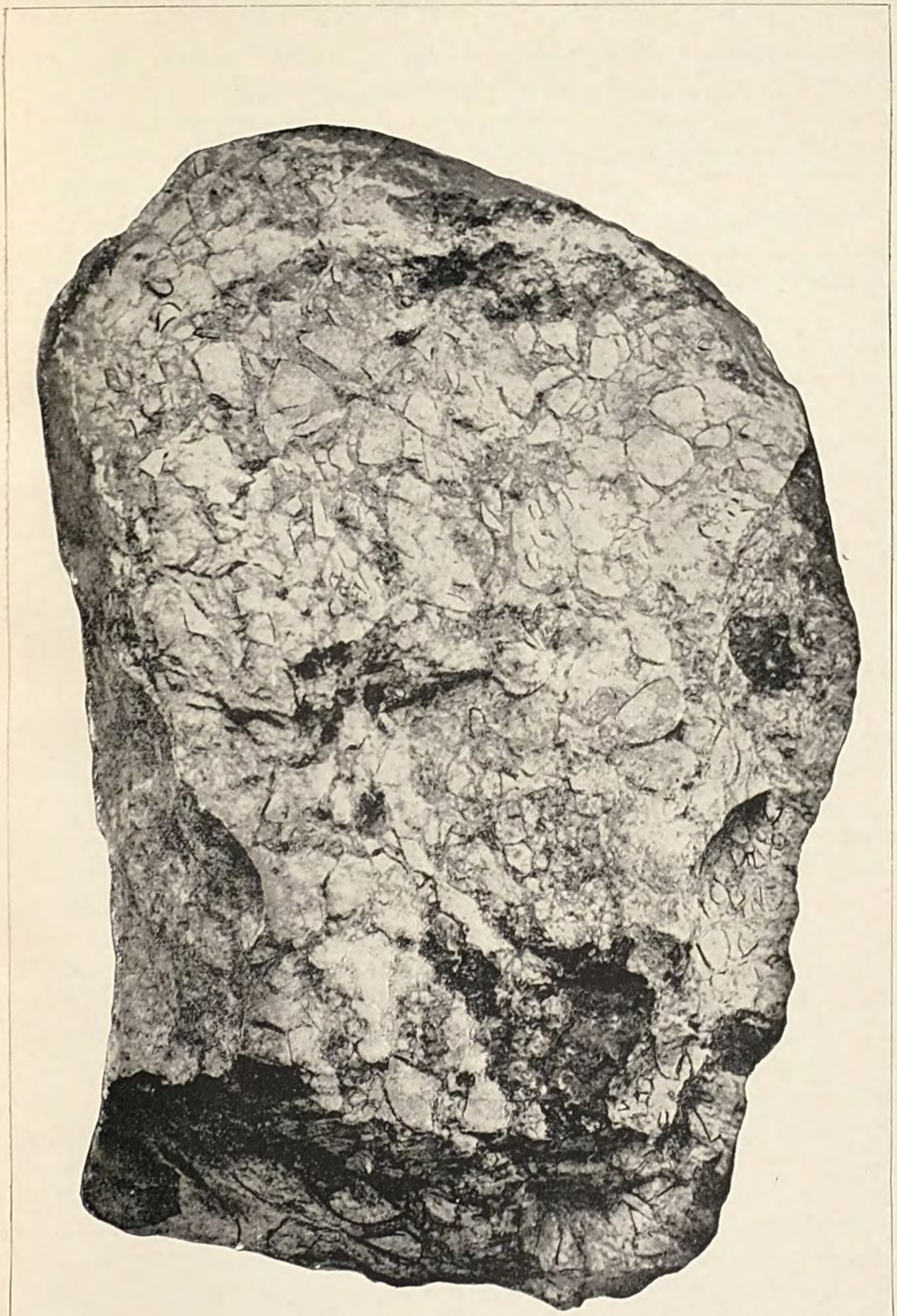
G. H. Williams, Bull. U. S. Geol. Survey No. 62, pp. 61, 121, 212.

Bonney, On some nodular felsites in the Bala group of North Wales: Quart. Jour. Geol. Soc. London, Vol. XXXVIII, p. 289.

Callaway, On the genesis of the crystalline schists of the Malvern Hills: Quart. Jour. Geol. Soc. London, Vol. XLIII, pp. 530, 531.

P. L. Milch, Beiträge zur Kenntnis des Verrucano, 1892, pp. 128, 129.

[2] Rosenbusch, Pet. Massigen Gesteine, Vol. II, 2d ed., p. 411.



ACID BRECCIA, RACCOON CREEK.

Natural size. The photograph does not bring out clearly the brecciated character of the work, which is very pronounced in the specimen. The matrix is apparently an ash containing angular fragments of a larger size (average diameter 1 cm.). The colors are blue, gray, and buff.

mass. In the next stage the groundmass shows a decided tendency to a parallel arrangement, and sericite is more abundantly developed. Eventually the phenocrysts are obliterated and there is much sericite in the groundmass. It is not, however, developed to the exclusion of the feldspar, while the quartz remains unaltered.

In general, the development of sericite stands in direct relation to the shearing, and increases up to an almost complete, if not quite complete, replacement of the feldspathic constituents of the groundmass. Silica remains as a constituent of the groundmass.

Material obtained from an artesian well at a point 40 feet below the surface furnished a similar shear zone, which displayed an even more abrupt transition from a porphyry to a sericite-schist. A single microscopic section included both porphyry and schist in typical development. The former showed an early stage of the alteration which was complete in the latter, where only sericite and a very schistose siliceous microgranitic groundmass remained. In this case, and in the extreme stage of the transition previously described, it would be impossible, with the microscope alone, to decide whether the schists were of clastic or nonclastic origin. This is one of the instances where field evidence is quite essential to the authoritative determination of the origin of the rock.

At the Bechtel shaft there has been thrown out a mottled red and white schist which has been produced by the shearing of a massive felsite. Here the phenocrysts have been replaced by a quartz mosaic and some sericite, which is also largely developed in the groundmass. The red mottling is due to a more or less parallel arrangement of red iron oxide globulites.

A light green sericite-schist found on the railroad near Blue Ridge Summit station, and closely resembling some schists in situ exposed on the Gettysburg Railroad below the Clermont House, shows under the microscope phenocrysts of feldspar containing inclusions of a former glassy magma, still well preserved and showing twinning striations. These phenocrysts occur in a groundmass of quartz, a little feldspar presumably, much sericite, epidote, ilmenite, or magnetite, and leucoxene.

The color of the schist is due largely to the epidote.

At the exposure just now mentioned on the Gettysburg Railroad, east of the Clermont House, there occurs a handsome, light, silvery-green, crinkled sericite-schist. Several rods to the north of this exposure the railroad cuts through quartz-porphyry, but the contact between the porphyry and the schist is not exposed. The schist is similar to those already described, whose gradual passage into a massive porphyry could be followed in the field, and shows traces of phenocrysts under the microscope, and in the hand specimen on the surface at right angles to the cleavage. The cleavage surfaces often display exquisitely delicate and manifold dendritic tracery. (Pl. XIV.)

On the highroad from Fountaindale to Fairfield, not far from the "Old Copper Shaft," occurs a dark purple-gray spotted slate. The light-green spots are sometimes irregular, but more frequently possess crystalline outlines and prove under the microscope to be a sericitic alteration of feldspar phenocrysts. Much of the feldspathic material still remains. The groundmass consists largely of iron oxide, which by its prevalence obscures the other constituents—leucoxene and quartz.

Microscopic evidence is sufficient in this instance to determine the origin of the rock. It is plainly a sheared eruptive, and probably a porphyritic aporhyolite, although the irregular outline of some of the sericitic areas suggests a brecciated aporhyolite.

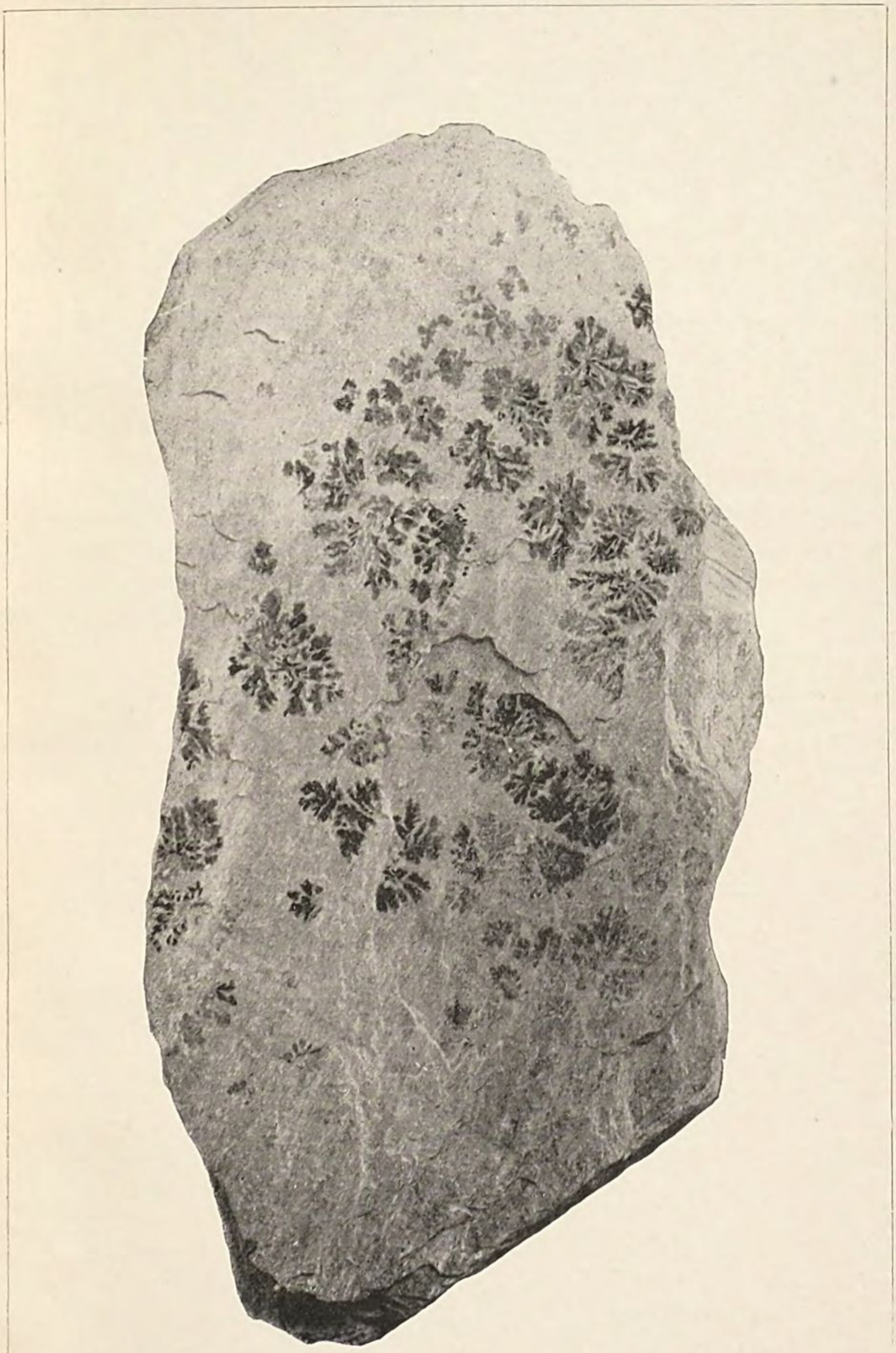
The occurrence of these slates is an interesting feature of the geology of the South Mountain. In the hand specimen they might readily be confused with a porphyroid, that is, a metamorphosed clastic rock, and have been so confused by geologists. They did not escape the attention of Professor Rogers, who alludes to them as "the fissile talcose rock" near the "reddish gray rock, containing specks of reddish feldspar," and includes them among the primal slates whose highly altered condition he repeatedly contrasts with the other slightly altered sediments (sandstone). If these slates were of clastic origin, a high degree of metamorphism was necessary to produce their present crystalline condition, and Professor Rogers was quite right in drawing a contrast between their extreme metamorphism and the comparatively unaltered condition of all the other sediments. The very fact that their development from a sediment calls for such a high degree of metamorphism confined to limited and isolated zones, and for which no adequate cause can be assigned, renders such an origin as improbable as it is unnecessary. Such a "selective metamorphism" is not demanded by the facts.

As a matter of fact, these slates are scarcely more altered than the sandstone. Dynamic action in the latter has developed a quartzite. Dynamic action in the less resistant porphyry and aporhyolite has produced a sericite slate. That the chemical character of the acid rock remains essentially unaltered is evinced by analysis I, given on page 61. This shows exactly the composition of a rhyolite, and is totally unlike that of the sediments of the region. The sedimentary argillaceous slates of South Mountain are very little altered, and exhibit no tendency toward the development of porphyroids.

All evidences—field relationship, successive stages shown in the hand specimen and under the microscope, chemical character, inherent improbability of clastic origin—combine to reveal the igneous character of these acid slates.

SUMMARY.

The acid igneous rocks of the South Mountain have proved to be quartz-porphyries, devitrified rhyolites (aporhyolites) with accompanying pyroclastics, and sericite-schists.



SERICITE SCHIST.

From exposure on the Gettysburg Railroad just below (east of) the Clermont House. One-half natural size. It shows the dendritic markings which are frequently to be seen upon the cleavage surfaces of the acid slate.

The first are typical holocrystalline porphyries, characterized by a soda-feldspar and by the presence in many cases of accessory piedmontite. The second group are the prototypes of the modern rhyolites, differing from them only in the loss of a vitreous base through devitrification. They are without phenocrysts, with inconspicuous phenocrysts, and with abundant and conspicuous phenocrysts. Like the porphyries, they are characterized by a soda-feldspar—that is, they are of the pantellerite type. The evidence for devitrification lies in the abundant presence of structures peculiar to glassy lavas, in the present holocrystalline character of the rocks, and in the empirical knowledge that glass may become crystalline through lapse of time.

The sericite schists are a metamorphic product of the first two classes by means of dynamic action.

The alteration which the original types have undergone subsequent to consolidation is, in the case of the aporhyolites, devitrification (statical metamorphism); in the case of the schists, sericitization (dynamical metamorphism); and in the case of all three groups, including the quartz-porphyries, an epidotization (weathering).

CHAPTER V.

PETROGRAPHICAL DESCRIPTION OF THE BASIC ERUPTIVES.

NOMENCLATURE.

Many of the petrographical data upon which uniformitarian arguments have been based have been drawn from the comparative study of basic eruptives, and there is a marked disposition to disregard age in the nomenclature of these rocks. Among German petrographers, Reyer,[1] Tietze,[2] Reiser,[3] Reusch (H. H.),[4] and Suess[5] have supported the view that age is not a just ground of distinction between eruptive rocks, and Rosenbusch[6] predicts that in no very distant future the separation of effusive rocks into an older and a younger series "will prove untenable." English and American petrographers are practically disregarding age in their nomenclature of the basic igneous rocks. Among the former, Judd,[7] Teall,[8] Allport,[9] Bonney,[10] Phillips,[11] and Hobson[12] are notable. Among American petrographers, the Danas[13] and Iddings[14] have disregarded age in their usage of basic rock names.

In plagioclase-augite rocks, the distinction between the gabbro and the diabase groups has been finally recognized as structural and not mineralogical, and the distinction between the diabase and the

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[1] E. Reyer, Beiträge zur Fisik der Erup., 1877, pp. 142–171; ref. Hussak: Neues Jahrbuch für Mineral., etc., 1892, Vol. II, p. 147. Beiträge zur Fisik der Erup. und der Eruptivgesteine. 1887, p. 135.

[2] E. Tietze, Das Altersprincip bei der Nomenclatur der Eruptivgesteine: Verhandl. k. k. geol. Reichsanstalt, Wien, 1888, p. 166; ref. F. Becke: Neues Jahrbuch für Mineral., Vol. II, 1884, p. 303.

[3] Karl A. Reiser, Ueber die Eruptivgesteine des Algaü: Tschermaks mineral. Mittheil., Vol. X, 1889, pp. 500–550.

[4] H. H. Reusch, Ueber Vulkanismus, Berlin, 1883.

[5] Suess, Das Anthtz der Erde, Vol. I, pp. 204–206, 1883.

[6] H. Rosenbusch, Ueber die chemische Beziehungen der Eruptivgesteine: Tschermaks mineral. Mittheil., Vol. XI, 1890, p. 146.

[7] Judd, On the gabbros, dolerites, and basalts of Tertiary age in Scotland and Ireland: Quart. Jour. Geol. Soc. London, Vol. XLII, 1886, pp. 49–97. The secondary rocks of Scotland: Quart. Jour. Geol. Soc. London, Vol. XXX, 1874, pp. 220–303.

[8] Teall, Address of the president Geol. Sec. (*e*) of the British Assn. Adv. Sci., 1893.

[9] Allport, On the basaltic rocks of the Midland coal fields: Geol. Mag., Vol. VII, No. 70, 1870, pp. 159–162 Tertiary and Palæozoic trap rocks: Geol. Mag. Vol. X, 1873, p. 196.

[10] Bonney, Quart. Jour. Geol. Soc. London, Vol. XXX, p. 529.

[11] Phillips, On the so-called greenstones of central and eastern Cornwall: Quart. Jour. Geol. Soc., London, Vol. XXXIV, p. 471.

[12] Hobson, On the basalts and andesites of Devonshire: Quart. Jour. Geol. Soc., London, Vol. XLVIII, 1892, pp. 496–507.

[13] J. D. Dana, On some points in lithology: Am. Jour. Sci., 3d series, Vol. XXXVIII, 1878, pp. 336, 438. E. S. Dana, Trap rocks of the Connecticut Valley: Proc. Am. Assn. Adv. Sci., 1884.

[14] Iddings, The columnar structure in the igneous rock on Orange Mountain, New Jersey: Am. Jour. Sci., 3d series, Vol. XXXI, May, 1886, p. 331.

basalt (dolerite) as one of the degree and granosity of the crystallization. It is easy to see that these features are determined by the geological conditions of consolidation. It follows from this that the essential characteristics of the rock groups are independent of age.

A history of the classification of the gabbro and its allied groups and an exact statement of the final definition of these groups have been concisely given by Dr. Bayley.[1] He suggests that the group of melaphyres and augite-porphyrites will eventually be dispensed with, when the olivine diabases and the diabase "will take the position thus left vacant, and the plagioclase-augite rocks will be found to occupy these places with respect to each other; the gabbros, the position of a deep-seated rock; the diabases, that of the corresponding holocrystalline effusive; and the basalt, that of the hypocrystalline equivalent." With this understanding of the use of the terms diabase and basalt, the South Mountain basic rocks fall into the diabase group.

They are holocrystalline, effusive, plagioclase-augite rocks, with or without olivine. They thus possess the characteristics of the augite-porphyrites and melaphyres (diabase group). They are so fine-grained as to appear homogeneous in the hand specimen, yet show no evidence in the thin section of an originally hypocrystalline character. There is no proof for or against devitrification. In the absence of such proof their present holocrystalline character will be recognized in their nomenclature as primary.

MELAPHYRES AND AUGITE-PORPHYRITES.

DISTRIBUTION.

The quartz-porphyries and aporhyolites in the Monterey district are limited to numerous small detached areas. The melaphyres and augite-porphyrites, on the other hand, occupy a large, irregular area, covering the valleys, the foothills, and the mountain flanks. Besides this area, which constitutes about one-half of the entire district, there are two small areas north of the old Maria Furnace, which are surrounded by the acid rocks, thus reversing the usual relation of the basic and acid eruptives. Along the State line and to the south of that line the diabases are massive or schistose, and inconspicuously amygdaloidal. In the Monterey district the amygdaloidal character of the diabases is their most marked feature. In the exposures on the Gettysburg Railroad narrow zones of inconspicuously amygdaloidal or nonamygdaloidal melaphyres grade above and below into conspicuously scoriaceous rocks.

Basic igneous slates occur at the west end of the Gettysburg tunnel, where they grade into massive diabases. They also occur on Colonel Benchoff's place, at a locality just north of Gum Spring, on a line northeast of the Blue Ridge Summit station, and form a knoll south of the Fountaindale post-office. (See map, Pl. I.)

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[1] The basic massive rocks of the Lake Superior region: Jour. of Geology, July-August, 1893, Vol. I, No. 5, pp. 433-456.

There are a few other localities where slates occur. Where the slates were not studied in thin section their igneous origin has not been considered as proved.

Ash beds, diabases crushed and recemented with epidote and quartz, are exposed along the Gettysburg Railroad in the cuts west of the tunnel.

A tuffaceous breccia, composed of fragments so rounded as to appear waterworn, was found at the head of Minie Branch. At the Russel copper mine and a few other localities epidosites are abundant. At the former place they are evidently vein material, and carry the native copper. In other localities they undoubtedly represent the last stages of decomposition and alteration of the massive or more often of the tuffaceous diabases.

MACROSCOPICAL DESCRIPTION.

The augite-porphyrites and melaphyres vary in color from a slate-blue or purple to all shades and tones of green. Where epidote is the predominating alteration mineral the prevailing color is light yellowish-green; with chlorite or actinolite as the alteration products the color is a dark green.

The most persistent and striking feature of the augite-porphyrites and melaphyres is their amygdaloidal character, to which allusion has already been made.

Bowlders on the roadside and in the fields show a curiously rough and pitted surface, due to epidote or quartz amygdules brought out in relief by weathering. Sometimes the bowlders closely resemble conglomerates composed of green or white oval pebbles; or the quartz amygdules, when perfectly spherical, mimic the spherulites of the acid rocks.

The diabases (augite-porphyrites and melaphyres) are rarely massive, usually schistose, sometimes slaty, and almost universally amygdaloidal.

As the amygdules quickly respond to pressure, they furnish a delicate test of the degree of schistosity present in the rock. Macroscopically the schistosity is otherwise more or less obliterated by subsequent epidotization or chloritization.

Genuinely massive diabases are exceptional in occurrence and limited in extent. Occasionally a mass of rock has moved as a whole, under pressure, and thus close to schistose or even slaty diabase the rock may retain its massive character. In these cases, since there has been no shearing, the vesicles are often perfect spheres, showing no elongation from magmatic movement. This is notably the case just north of Gum Spring, on the Old Furnace Road. Quartz amygdules show conspicuously as round white spots on the fresh surface of the rock, which is a dark blue-gray, or are brought out in relief on the weathered surface, giving the rock the appearance of being riddled

with shot. In other localities there is a greater diversity both in the shape and in the composition of the amygdules.

There is frequently a zonal arrangement of three minerals—epidote, chlorite, and quartz—the light-green epidote being developed on the edge of the vesicle and surrounding the chlorite and quartz, which are successively developed in the interior. Where the vesicles are large, epidote sometimes occurs in beautiful radiating crystals, not completely filling the vesicle, and occasionally associated with crystallized malachite.

It is doubtless to these amygdules that Professor Rogers refers when he describes the "decidedly crystalline" primal slates as containing "segregated specks and even half-formed geodes of epidote and other minerals," or "as gray slate spotted with epidote." Wherever there has been sufficient shearing to form a slate a micaceous mineral is formed in the vesicles. This micaceous mineral is either sericite, when the slate is conspicuously ornamented with greenish-white oval spots, or it is chlorite, when the slate is marked with brilliant dark-green oval spots.

The nonamygdaloidal diabase is always more or less schistose and frequently slaty. At the second railroad cut beyond Gladhill's switch it has a banded appearance, due to an alternation in color, purplish green, dark and light green rapidly succeeding one another. The rock is fine-grained. The form of the banding and the structure of the rocks as disclosed by the microscope suggest that the bands represent ash beds.

At the west end of the tunnel there is a curious differentiation of the diabase in color and sensitivity to pressure. This differentiation is limited to an irregular band which suggests in many ways an intrusive dike. The apparent dike traverses the nonamygdaloidal diabase in a direction oblique to the schistosity of the latter. At one end it diverges and sends out a branch which pursues a course vertically downward and disappears beneath the surface.

Fragments of the schistose diabase are included within the dike. Its upper surface is somewhat amygdaloidal, the interior compact, and the lower surface bordered by a band of light-yellow epidote. This band is more irregular in outline than the upper surface.

The dike is intersected by two systems of fine parallel, or approximately parallel, quartz veins. Parallel to one of these systems is an easy cleavage.

The diabase just above and below the dike is finely schistose. This schistosity is parallel to the course of the dike, and is particularly remarkable above the dike, where it follows every curve of the latter. The color of the dike is purplish, and contrasts with the surrounding dark-green diabase.

The obliquity of this seeming dike to the general schistosity of the diabase, its inclusions of fragments of the surrounding schist, its divergent branches, and the foliation of the diabase parallel to the

band are all more readily explained on the supposition that we are dealing with a genuine igneous dike than in any other way. The structure of the rock under the microscope and its analysis (see Analysis III, p. 78) show that there is no essential difference in these characters between the band and the schistose diabase which it traverses. Its chemical composition differs only in the high percentage of iron which it carries. It is possible that for some cause there has been a local concentration of iron (to which the color is due) within the limits of this band, which renders it harder than the surrounding diabase and enables it to resist pressure more successfully. Hence, while not yielding itself to the pressure which produced the schistosity of the diabase, it has also been the means of producing a foliation in the diabase parallel to itself. The only other tenable hypothesis is that it represents a later intrusive lava flow of the same general composition as that of the rock into which it was intruded. The manner in which it grades into a finely vesicular rock on its upper surface, and the inclusions of fragments of a green diabase, would be explained by this hypothesis. Its resistance to pressure would be due to the same cause in either case.

In only a few instances do the diabases show a porphyritical structure apparent to the naked eye. The diabases have not infreqently suffered crushing, and are recemented with quartz, epidote, and hematite, the former minerals predominating. Veins of asbestos with quartz occur in the more epidotic diabase.

MICROSCOPICAL DESCRIPTION.

Original structures.—There is a marked uniformity of structure and of mineral constituents in the South Mountain diabases.

Unlike the aporhyolites, the porphyrites and melaphyres do not show the effects of magmatic movement. Their structure is universally the ophitic, which is produced only in a magma in a state of equilibrium. The vesicles also, as has already been noted, do not betray any fluidal movement. (Pl. XXVIII, *a*.)

Crystallization is fine-grained (see p. 69), corresponding to what has been called the "microophitic." That originally this microophitic structure was associated with and passed insensibly into the hyalopilitic is not impossible, although subsequent processes of alteration, chief among which is silicification, have destroyed all trace of an unindividualized base.

Shearing has obscured and sometimes obliterated the delicate ophitic structure through processes detailed later. Where dynamic action found relief in the crushing of the rock rather than in the production of a schist, the ophitic structure remains perfectly preserved in the rock fragments. The porphyritic structure is inconspicuous. Among the nonolivinitic porphyrites intratelluric crystallization is nearly absent. Feldspar and augite phenocrysts are rare. This characteristic, together with the widespread development of the amygdaloidal structure, allies these rocks to Rosenburch's *spilite* type.

The olivinitic porphyrites, or true *melaphyres*, contain olivine as a constituent of the groundmass as well as in the very plentiful porphyritical crystals.

The distribution of the melaphyres is quite similar to that of the spilites. The history of the two types since consolidation has been the same, and they will be discussed together.

The vesicular structure is a conspicuous feature of the melaphyres and spilites. They range from rocks almost as vesicular as a sponge to a compact rock containing only a few scattered vesicles. These vesicles are filled with material furnished by percolating waters, and a solid amygdaloid is formed.

The mineral nature of the amygdules will be described under the secondary constituents. The vesicles vary in size from microscopic dimensions to 5 centimeters in length and 3 in breadth. They are very significant, both of the amount of shearing and of alteration present in the rocks which they characterize, and they have undoubtedly been a factor in determining the character of both processes (pp. 74–75).

Secondary structures.—The micropoikilitic structure, as has been noted on page 49, is occasionally present. It is found in those melaphyres and spilites which have been thoroughly silicified by infiltration. The secondary nature of the structure is very plain. The original structure (the ophitic) is so well preserved, in spite of the replacement of the mineral constituents, that in ordinary light the altered character of the rock is scarcely apparent (Pl. XIX, *a* and *b*). Polarized light at once betrays the extent of the alteration.

Where the schistose character of the rock is pronounced in the hand specimen, it is also a marked feature of the thin section. The constituents, which in these cases are for the most part secondary, are arranged with their longest axes at right angles to the pressure.

There has been so complete a recrystallization of the rock as to obscure its original character. It has been repeatedly pointed out that under conditions of pressure igneous rocks acquire a degree of schistosity which renders it almost impossible to determine their true character and to distinguish authoritatively between foliated traps and metamorphosed slates (clastics). In the schists under discussion their relation to undoubted porphyrites leaves no room for doubt as to their origin, nor is their alteration so extended as has been described in other localities. The structure of the South Mountain porphyrites is usually far less altered than is the case with the greenstone schists of the Menominee and Marquette regions.

Original constituents.—It is to be expected that these ancient rocks, comparatively soft and extremely vesicular, exposed as they have been to pressure, percolating waters, and weathering, should exhibit alteration. It is surprising that the alteration has not been so complete as to obscure altogether the original structures and constituents. The original constituents of the rock—plagioclase feldspar, augite, olivine, titaniferous magnetite—are either present in a comparatively fresh con-

dition or are represented by characteristic alteration products, which are often paramorphs of the original mineral. The former is only rarely the case, while the latter is the rule.

The feldspar occurs both as porphyritic crystals and as a constituent of the groundmass. The crystals of the first generation are from 0.6 to 0.8 millimeters in length to 0.2 millimeters in breadth. Those of the second generation are lath-shaped, 0.4 millimeters in length to 0.4 millimeters in breadth, and condition the microophitic structure. They are both striated, and show undulatory extinction when any of the original substance remains. Usually the feldspars are altered to epidote and quartz, or they have been completely replaced by quartz, while their crystal outline is preserved by the iron constituent.

It is doubtful whether augite is present otherwise than as a constituent of the groundmass where it is allotriomorphic. It is universally replaced by the more stable amphibole minerals or by epidote or chlorite, and some porphyritic crystals of the latter minerals may represent augite phenocrysts. The chief alteration product of augite in the schistose porphyrites is actinolite. This mineral is not limited in its development to the augite outlines, and it thus obscures the ophitic structure. Olivine crystals of two generations are readily recognized by means of their characteristic form, their irregular fracturing, and sometimes by their alteration products. Usually the olivine is altered to epidote. In a few cases (Pl. XXVIII, *b*) the crystals are still sufficiently unaltered to respond to the optical tests for olivine.

There is a large amount of an opaque black oxide in the porphyrites. Where this was tested the powder was found to be magnetic. This fact, the crystal form of some of the oxide, and the analyses of these rocks point to the conclusion that much of it is magnetite, though undoubtedly very titaniferous. Occasional rhombohedral forms and cleavages indicate that ilmenite is also present. Both these minerals have given rise to an abundant development of leucoxene (Pl. XXVIII, *b*).

In order of abundance the original constituents rank as follows: feldspar, augite, magnetite and ilmenite, olivine.

Secondary constituents.—The processes of alteration have been greatly assisted by the open-textured, vesicular nature of the rocks, and the mineral character of the amygdules is indicative of the character of the alteration of the rock mass. The vesicles are almost universally filled with one or two or all of three minerals: epidote, quartz, and chlorite. Whatever is the amygdaloidal filling is also the prevailing alteration mineral. If quartz fills the amygdules the rock mass is more or less completely silicified. The ophitic structure, while preserved in outline, is replaced by the micropoikilitic. Quartz, titaniferous magnetite, leucoxene, and some epidote constitute the rock, which is distinguished in the hand specimen by its blue-gray color and white amygdules.

One of the most common amygdaloidal fillings is epidote with a

little quartz. In this case epidote is the predominating alteration product. These rocks are recognized in the hand specimen by a light-green color and green amygdules. Feldspar, augite, and olivine have all been replaced by epidote. The material for this mineral has undoubtedly been furnished by the interaction of feldspar and augite, and also has been brought to the rock by percolating water from overlying rocks. In the extreme phase of this alteration these rocks are true epidosites.

In the presence of a larger amount of iron, actinolite is abundantly developed. There is also much free iron oxide, and the rock becomes dark green in color. Where there has been shearing movement, as in the case of the acid rocks, a micaceous mineral is developed. In the aporhyolites the mineral is sericite; in the porphyrites it is chlorite. In the incipient stages of the schistose structure chlorite occupies the center of the amygdules, with quartz and epidote filling the rest of the space. When the rock is so schistose as to be fairly called a slate the amygdules are represented by brilliant dark-green spots and consist of chlorite only.

Chlorite in turn becomes the prevaling alteration product. Often none of the original constituents remain. Actinolite, chlorite, epidote, and secondary silica are the invariable constituents of the "spotted greenstone schists." The actinolite and chlorite both blur the outlines of the original constituents and obliterate the original structure. These rocks are a medium green in color.

The important secondary constituents of the porphyrites are quartz, epidote, actinolite, chlorite, and leucoxene. The prevalence of one or the other of these alteration products can be determined in the hand specimen by means of the color of the rock and the character of the amygdules. With reference to the character of the alteration which they have undergone, the melaphyres and spilites thus fall into the following groups:

1. A blue-gray rock with quartz amygdules which do not show shearing. Under the microscope it shows an ophitic structure well preserved, and a silicified groundmass. Localities: Near Gum Spring, on the Old Furnace road, on Minie Branch, and along the Gettysburg Railroad.

2. A light yellowish-green rock with epidote-quartz amygdules, and epidote as a prevailing constituent. The original structure is obscured. Localities: South of the Clermont House on the Gettysburg Railroad and at the Russel copper mine.

3. A medium-green spotted schist. Chlorite is the prevailing mineral. The original structure is more or less completely obscured. Localities: Along the State line at the west end of the tunnel and at many other places. This is a prevailing type of the porphyrite.

4. A dark-green rock, more or less schistose. Epidote, quartz, and chlorite form the amygdules. Actinolite is abundant as an alteration

product. Feldspar is often fresh and unaltered and the structure preserved.

In the first three types actinolite may also be present, but not so abundantly as in the last. The first type passes into the second by increase in epidote, and the second type grades readily into the third by increase in chlorite. As this increase accompanies the development of schistosity, most of the schists belong in the third group.

Types 3 and 4 are not sharply separated. Chlorite and actinolite are present in both. In the former chlorite predominates, and in the latter actinolite.

Olivine may be present in any of the four groups. The crystal outlines are best preserved in the first group; hence the ophitic structure is here best preserved; and it is most obscured in group 3, where original crystal outlines are lost.

Group 1 contains the rocks which have been the least sheared, a fact which is perhaps accounted for by the silicified character of the rock.

The peculiar dike-like band which traverses the basic eruptives at the west end of the tunnel is not unlike type 1 in color and compactness of texture. The color is several shades darker, and the specific gravity of the rock is greater. Under the microscope a further remsemblance is seen. The compact rock mass consists largely of titaniferous magnetite (arranged in layers, or outlining obscurely an ophitic structure), chlorite, epidote, and quartz.

The amygdaloidal selvage of the band shows the same constituents in an inverse proportion, and the ophitic structure is strongly marked. This was true in all the numerous thin sections made of the band. In the vesicular portion of the band the ophitic structure is well preserved, and even olivine crystals with unaltered outline are present. The amygdules are filled with quartz, granular and crystalline epidote, and chlorite. It is probable that the yielding of the vesicles, which would offer the least resistance to pressure, saved the rock. The tendency to a parallel arrangement of the feldspars on either side of the amygdules accords with this supposition. The passage of this band, which is sometimes only from an inch to two inches wide, into a green chlorite-schist or slate is very abrupt. The difference seems to be due to the presence in the band of a large amount of iron. Its chemical analysis, given on page 78, coincides with this view.

Epidote and quartz are by far the most abundant and widely distributed of the secondary minerals. This is true not only of the basic eruptives, but also of the acid eruptives when they are the prevalent alteration products and amygdaloidal filling, and where piedmontite, a member of the epidote group, occurs in macroscopic quantities. There seem to have been conditions favoring an extensive epidotization and silicification. Undoubtedly there has been within the rocks themselves a mutual reaction between the decomposition products of feldspar and augite resulting in the production of epidote. The fact that

rarely some fresh feldspar still remains, while the augite is always decomposed, indicates that the decomposition products of augite have acted upon fresh feldspar, thus also developing epidote. But the feldspars and augite of the porphyrites under discussion will not account for all the epidote and quartz present in them, composing, as they do, the amygdules, and in many cases the entire rock. The dip of the foliation planes of the basic eruptives indicates a thickness formerly much greater. A large amount of erosion of the igneous rocks has occurred since they were elevated to their present position. The water which percolated through this great thickness of igneous material brought with it the lime and alumina.

It is plain that these processes of epidotization and silicification took place not only while the porphyrites were being elevated, but have continued since the cessation of all dynamic action. The filling of vents and cracks by these materials, the fresh, unschistose character of the epidote and quartz in vesicles which themselves show the effect of squeezing, the presence of granular epidote in the schists and slates, all lead to this conclusion. While this is true, there are, on the other hand, amygdules of epidote where the fan-shaped radiating crystals of epidote have been broken and pulled apart in consonance with the alteration in the shape of the vesicle, and the spaces thus formed filled with silica.

The nonvesicular character of the acid eruptives has saved them from so extended an epidotization as characterizes the basic eruptives. In the case of the amygdaloidal aporhyolites of the Bigham copper mine, the same conditions which obtained with the porphyrites have operated to effect with them an extended development of epidote. While there is so complete an alteration in mineral constituents, there is surprisingly little change in structure.

In this respect the South Mountain basic eruptives are a contrast to similar greenstones of the Menominee and Marquette regions. A comparative study of the greenstones of the two regions shows that the Lake Superior rocks, while more altered in structure, possess feldspars less altered than do the South Mountain greenstones. Calcite is much more abundant in the former rocks, and epidote in the latter, as a secondary product.

Acessory minerals.—Copper occurs in microscopic quantities in the amygdules of the basic eruptives, just as it did in the amygdaloidal aporhyolites. This is true only of the amygdaloids from the various copper-mine localities described on pages 25–27. At these localities the carbonates of copper, malachite and azurite, occur as thin stains. The former sometimes forms crystals of considerable size in the vesicular cavities (one-fourth inch). A silvery-green asbestos occurs in some abundance in quartz veins penetrating the basic eruptives. It is plainly a secondary product. A finely divided red hematite is sometimes quite conspicuous in the amygdules as a cementing material for

the crushed porphyrites. It also occurs in crystalline form, and at a single locality (south of the Fountaindale turnpike, on the north flank of Haycock Mountain) micaceous hematite occurs in veins. Calcite is rare. It is occasionally present in the amygdules or as vein material; and in the case of a single specimen, broken from a roadside bowlder, it almost completely replaces the substance of the rock.

The range of minerals, original, secondary, and accessory, found in the South Mountain rocks is a very limited one.

DISCUSSION OF CHEMICAL ANALYSES.

The analyses tabulated below, with the exception of No. IV, are collected from analyses scattered through the publications of the Second Geological Survey of Pennsylvania. For Analysis IV the writer is indebted to the courtesy of Professor Daniells, of Wisconsin University:

Table of analyses.

	I.	II.	III.	IV.	V.
SiO_2	48.93	48.02	41.280	37.225	37.03
P_2O_5	.....	1.45	.....	.....	0.51
Al_2O_3	15.42	17.84	18.480	44.82	24.13
Fe_2O_3	14.71	11.61	9.440		.....
FeO	.....	.98	8.200		19.03
TiO_2	.....	.....	.....	.....	4.05
CaO	18.16	18.25	7 040	15.79	0.21
MgO	2.78	.....	7.486	1.14	1.44
K_2O	.....	.....	2.208	.....	8.93
Na_2O	.....	.....	3.523	(1)	Trace.
Ignition	.....	1.50	2.740	.....	3.54
Total	100.54	99.65	100.397	98.975	99.67

[1] Not determined.

I. "Orthofelsite, containing epidote, 11¾ miles west of Gettysburg."[1]

II. "Epidotic rock, 2½ miles from Mount Alto furnace."[1]

III. "Chloritic schist from Bechtel shaft."[2]

IV. Differentiated band at the west end of the tunnel.[3]

V. "Variegated chlorite-schist with chlorite (?), one-half mile northeast of Pine Grove."[1]

The characterization of these rocks by the Second Geological Survey is somewhat vague, and in the discussion of the analyses the writer is again hampered by the lack of hand specimens of the rock analyzed.

The percentages are about those of the normal augite-porphyrites and melaphyres as given in Roth's tables. They scarcely show as much variation as the altered augite-plagioclase rocks of his tables.

Although the analyses show some phosphorous pentoxide, no apatite was noted in the microscopic study. The iron percentage is high in all of the analyses, though not abnormally so—not higher than the microscopic study would lead us to expect.

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[1] Second Geological Survey of Pennsylvania, Vol. CCC, pp. 255-275. Analyses made by the late Dr. F. A. Genth.

[2] Frazer: Hypothesis of the structure of the copper belt of the South Mountain, p. 82; Trans. Am. Inst. Min. Eng., Vol. XII, pp. 85-90. Analysis made by C. Hanford Henderson.

[3] Analysis made by Prof. W. W. Daniells, of Wisconsin University.

The "epidotic rock" (I and II) shows, as would be expected, an abnormally high lime percentage.

The chief variation from the normal type lies in the addition of lime and iron oxide and the abstraction of the alkalies and magnesia.

BASIC SLATES.

DISTRIBUTION AND DESCRIPTION.

The localities where the basic slates occur in any considerable extent are colored a light yellow-green on the map of the Monterey district. The slight rounded eminence opposite the Fountaindale post-office is composed of a dark-gray crinkled and finely laminated slate. It is darker colored than the clastic slate of the region and is surrounded by the basic eruptives. The thin section shows very distinct traces of an ophitic structure. Iron oxide, chlorite, and sericite are the only constituents that can be determined. About three-fourths of a mile north of Monterey station, on the road leading from the turnpike to the Old Furnace road, there is an exposure of a lighter-colored slate. The same constituents are found in this slate, with a larger proportion of sericite and the addition of leucoxene. The ophitic structure is barely discernible, and it is with considerable hesitancy that the slate is referred to the group of igneous rocks. Half a mile farther northeast, on the Old Furnace road, just beyond Gum Spring, occurs a light-gray spotted slate of undoubted igneous origin. It is not so finely foliated as the slates that have just been described, and much of the original structure remains. The constituents are the same as those of the last-mentioned slate. Leucoxene is more abundant and the ophitic structure is pronounced.

The amygdules, which give the slates a spotted appearance, are composed of quartz, sericite, and some chlorite. These slates are related to the porphyrites of Group I, some typical examples of which occur near by.

At the west end of the Gettysburg tunnel, just above the iron-bearing band previously described, another spotted slate has been developed from the basic igneous rock. In this case the slate is green, and the spots are a brilliant dark shade of the same color. Iron oxide, chlorite, epidote, and some silica are the constituents. The original structure is entirely obliterated. Some of the epidote grains faintly suggest olivinitic forms. Chlorite is the prevailing mineral. The spots, which as in the other slate are sheared amygdules, are formed of chlorite only. This slaty zone is only a few inches wide and passes somewhat abruptly into a slightly schistose porphyrite.

The first tunnel on the old Tapeworm Railroad, which was abandoned before an excavation was made, exposes a green slate which differs from the one just described only in its nonamygdaloidal character and in the greater abundance of epidote. The knoll northeast of Blue Ridge

Summit station, the roadway crossing the Gettysburg Railroad in front of the Clermont House, and the hill to the east of the Fairfield-Fountaindale road and north of the Fountaindale turnpike, are the other localities where slates occur. While their association and their appearance in the hand specimen, which resembles that of the first two slates discussed, indicate an igneous origin, in the absence of thin sections that origin can not be considered beyond question.

BASIC PYROCLASTICS.

DISTRIBUTION AND DESCRIPTION.

The basic breccias of South Mountain may be classified as follows: (1) Crushed porphyrites which have been recemented with epidote and quartz and sometimes brilliantly colored with red hematite; (2) Tuffaceous breccia; (3) Ash.

(1) *Crushed porphyrites.*—The crushed and broken porphyrites, while perhaps not in a strict sense breccias, present a strikingly brecciated appearance. Fragments of all sizes, of a blue or purple-gray rock, are embedded in a bright-green and white or rose-colored matrix. The fragments have undergone either silicification or epidotization without affecting materially their structure (microophitic), which is outlined by iron oxide.

(2) *Tuffaceous breccia.*—Some large bowlders found near the source of Minie Branch furnish the only unmistakable tuffaceous breccia. The fragments show a considerable range in size (see page 24) and are thickly crowded in a basic cement. As there has been no shearing, the structure of the fragments is perfectly preserved. (Pl. XXVIII, *a*.) Epidote, quartz, and iron oxide are their present constituents.

(3) *Ash.*—Above the Headlight copper mine on the Fountaindale turnpike and in the fourth cut beyond Monterey station (northeast), on the Gettysburg Railroad, are intercalated bands of a light-green rock which, for the following reasons, have been considered altered ash: At the west end of this cut a fine-grained homogeneous rock is striped with alternating bands of light green and reddish green. Under the microscope these bands show no trace of any structure save a slight schistosity. They are composed almost wholly of angular grains of epidote, magnetite and leucoxene, actinolite, chlorite, and quartz. The difference in color is due to the presence in the reddish bands of red iron oxide. Toward the eastern end of the same cut the whole face of the rock is banded with light-green epidotic layers from 1 foot to 2 feet wide, running approximately parallel to one another.

A microscopic slide of one of these bands consists wholly of granular epidote and quartz, with a little iron oxide, usually the red oxide.

These rocks overlie and are in close proximity to scoriaceous basic lava. This fact, together with their variation in color and their structureless and fragmental character, is very suggestive of an altered ash. At the first locality mentioned, the Headlight copper mine, the so-

called ash occurs as a light-green schist. It is not banded, but presents under the microscope the same structureless character as the rocks above described. It consists of actinolite blades and needles, epidote granules, and some chlorite, magnetite, and leucoxene.

SUMMARY.

The basic igneous rocks display but little variety of structure or mineral constitution. The former is that common to porphyrites and melaphyres—the microophitic—and in spite of great alteration in the mineral constituents of the rocks it still remains a marked structure. Shearing obscures it, but in the extreme form of the sheared porphyrite—the slate—it is still discernible.

The formation of chlorite and actinolite tends to confuse outlines; hence some of the slates in which there is not much of these minerals preserve their original structure better than the chlorite-schists. The original mineral constituents, plagioclase, feldspar, augite, and olivine, have almost completely disappeared. No augite remains; olivine crystals are well preserved in outline, and sometimes a core of the original mineral remains. There is considerable feldspar still unaltered. It is always striated, but the crystals are too small to allow of an accurate determination of their character. That they belong to the basic end of the series is shown by their extended alteration to epidote, and by the chemical analyses of the rocks.

The vesicular character of these rocks has aided in the extended replacement of their original minerals, and the amygdules are an index of the character of that replacement. The presence of vesicles has also, doubtless, been a factor in preserving the internal structure of the rock in spite of dynamic action. Silicification, epidotization, and chloritization are the processes of alteration which have been most active.

The source of material is twofold—from the rocks in which these processes have been described, and from the overlying rocks which have been removed by erosion.

CHAPTER VI.

SUMMARY OF CONCLUSIONS.

EVIDENCE OF THE ERUPTIVE CHARACTER OF THE TWO ROCKS.

The preceding chapters have treated in detail structural and chemical features possessed by the South Mountain rocks and characteristic of igneous rocks *only*. These are regarded as sufficient evidence of the igneous origin of the rocks which they characterize, without further proof on that point. It only remains to show on what grounds a sedimentary origin has been attributed to them, and to sum up the evidence against such an origin.

FIELD EVIDENCE.

Schistosity.—The conformity of the foliation planes of the porphyries, the aporhyolites, and the porphyrites, with the foliation planes of the Cambrian sediments is a prominent and persistent feature, and one which, among others, has undoubtedly led to the ascription of a sedimentary origin to the former rocks. The confusion of foliation planes and bedding planes in the quartzite, owing to the obscurity of the latter, added force to this argument.

This conformable schistosity is not, of course, inconsistent with the igneous origin of the underlying rocks. The schistosity is a secondary feature, produced by forces which affected the igneous and aqueous rocks alike.

The cleavage is quite as plainly secondary in the clastic rocks as in the nonclastic, and sometimes conforms to the bedding and sometimes does not.

Lamination.—An original lamination, conspicuous in the aporhyolites, the nature of which was described on pages 43–44, characterized as bedding by Hunt and others, doubtless furnished another reason for attributing stratification and an aqueous origin to the rocks possessing it. The real nature of the lamination has proved to be such that it becomes an evidence of the igneous character of the rocks in which it occurs.

That the lamination is due to bands of spherulites has been pointed out. True spherulitic crystallization, such as has been described in these aporhyolites, has thus far been known only as the product of crystallization from a molten magma.

The slates.—The slaty character of the rocks has been another reason for assigning a sedimentary origin to them.

The slates, both acid and basic, have been considered clastic slates by Professors Rogers and Lesley, by Frazer, Tyson, Blandy, and Dr.

Hunt, as the quotations from these writers, given in Chapter I, show. While the igneous slates of South Mountain do not resemble any of the Cambrian sediments of that region, their resemblance to porphyroids from regions where there has been extended metamorphism is very great. This resemblance is internal as well as external, and furnishes an instance of the production of essentially similar results by either of two different methods.

The true nature of these slates and the manner of their production are conclusively revealed through field evidence. Where a single exposure shows a shear zone of not more than 20 feet in which every gradation from a porphyry to a fissile slate is displayed, or where a single hand specimen shows such a metamorphism, the evidence of such a genetic relationship is irrefutable.

Absence of gradation between igneous and clastic rocks.—There is, on the other hand, no such gradation between the igneous rocks and undoubted clastics as might be expected if the former were metamorphosed clastics. We have holocrystalline rocks sharply separated from noncrystalline clastics, with an entire absence of intermediate stages.

Professor Rogers was impressed with the high degree of metamorphism which these rocks must have undergone in order to attain their present holocrystalline character. "A gray siliceous altered rock," "a compact siliceous altered slate," are the terms he uses to describe the porphyries and aporhyolites, while he speaks of the porphyrites as "primal slate in a highly metamorphic condition" and "highly altered greenish slate." The sediments and the igneous rocks have been subjected to the same dynamic forces, and, as a matter of fact, we find one no more highly metamorphosed than the other relatively to their respective powers of resisting alteration.

Surface-flow features.—Positive field evidence for the nonsedimentary origin of these rocks is found in the features which they possess in common with surface flows. Their vesicular, scoriaceous, and pumiceous character, the accompanying pyroclastics, their flow structures, even grain, conchoidal fracture, and other characteristics of a glassy lava all testify to an eruptive origin.

PETROGRAPHICAL EVIDENCE.

Structural.—The petrographical evidence of the origin of the porphyries, aporhyolites, and porphyrites is of an even more unmistakable character.

Their porphyritic structure is indicative of their origin. Olivine and feldspar phenocrysts with crystalline outlines, idiomorphic quartz with embayments and edges rounded by magmatic corrosion, are possible only in rocks which have once been molten.

The ophitic structure, preserved in great perfection in the porphyrites, is peculiar to rocks which have consolidated from a molten magma,

Other structures which furnish additional and convincing proof of an igneous origin need only be mentioned. A detailed description of their appearance in the aporhyolites and porphyrites has been given in the previous chapters. Such structures are the spherulitic, axiolitic, lithophysal, perlitic, rhyolitic, fluidal, and amygdaloidal.

Mineralogical.—Metamorphosed sedimentary rocks are always accompanied by certain characteristic minerals. The absence of such minerals in these South Mountain rocks is conspicuous. Epidote and sericite are the only prominent alteration minerals. Of these, the former is the product of weathering rather than a true metamorphic mineral; the latter is more or less limited to shear zones, where its development is directly related to the dynamic force acting upon massive porphyries and aporhyolites. The absence of all evidence of contact action indicates their effusive character.

Chemical.—The close conformity of the composition of these rocks in the one case with that of the rhyolites and in the other with that of the diabases and melaphyres from all parts of the world, as tabulated by Roth, indicates an igneous origin. Their uniform composition is a contrast to the composition of a series of clastic rocks, where the chemical proportions are largely a matter of accident. A similar test has been applied by Rosenbusch [1] to the determination of the origin of Archean gneisses. The association of these types of acid and basic lava accord with the laws of petrographical consanguinity.

ORIGINAL ROCK TYPES.

ACID IGNEOUS ROCKS.

The acid-lava flows in South Mountain are regarded by the writer as quite comparable, at the time of their consolidation, to similar flows in post-Tertiary time, such, for instance, as those which have been recently studied in the Yellowstone National Park. Certain portions of the flow, as in the case of the Obsidian Cliff, were completely vitreous save for spherulitic and lithophysal crystallization. In other localities the lava was lithoidal, and in the central portion of thick flows holocrystalline. In this way three types of acid volcanics would be developed—rhyolites, lithoidal rhyolites, and quartz-porphyries. Every gradation between these types would accompany these.

Thus, while there are certain areas in the South Mountain, notably the Bigham Copper Mine and Raccoon Creek localities, which exhibit typical ancient rhyolites, other regions display genuine quartz-porphyries. While in the latter rocks, which constitute a not inconsiderable portion of the acid flows, the groundmass may have been, and probably was, originally holocrystalline, as in some modern lavas, in the case of the former rocks it is supposed that the groundmass was, at the time of consolidation, wholly or partly glassy.

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[1] Zur Auffassung der chemischen Natur des Grundgebirges: Tschermaks mineral. Mittheil., Vol. XII, 1891, pp. 49–61.

Chief among the processes of alteration which have been going on since that time is devitrification. Out of glassy and lithoidal rhyolites devitrification has been developing aporhyolites. This process consists in the replacement of whatever glassy base was present in the original rock by a uniform quartz-feldspar mosaic. Sometimes the alteration is carried still further, and the original spherulitic crystallization is also replaced by this secondary granular crystallization. Rarely, if ever, does the secondary crystallization completely obscure the former character of the rock, while often all of the structures peculiar to a fresh glassy lava are retained.

The other processes of alteration, which all of the original rock types have undergone in some slight degree, and some of them in an extreme degree, are the processes of sericitization and epidotization. The former process has been a chief factor in the development of slates from massive porphyrites and aporhyolites.

These three processes of alteration—devitrification, sericitization, and epidotization—represent statical metamorphism, dynamic metamorphism, and weathering, respectively.

BASIC IGNEOUS ROCKS.

In contrast with the acid rocks, the basic rocks have their original constituents so completely replaced that it is not easy to determine the original type or types. The original constituents were plagioclase, pyroxene, olivine, ilmenite, and magnetite. The original structures were the microophitic, the porphyritic (inconspicuous and mostly confined to the olivine-bearing type), and the amygdaloidal, a universal structure.

In view of these constituents and structures, these rocks have been regarded as members of the diabase or augite-porphyrite group and of the olivine-diabase or melaphyre group. The augite-porphyrites resemble the spilites in their scanty porphyritic crystals, their ever-present inclination to the amygdaloidal structure, and their susceptibility to weathering.

The character of the alteration which has taken place in these melaphyres and spilites varies with the amount of shearing which has occurred. Where shearing has been a factor in the alteration, chlorite, actinolite, and quartz replace the pyroxene and plagioclase.

In the absence of shearing, epidote has resulted from the interaction of plagioclase and pyroxene. Olivine has altered to epidote, serpentine, and iron oxide; ilmenite has altered to leucoxene, and magnetite to hematite, when altered at all. In the absence of shearing the ophitic structure is preserved in outline, although sometimes the micropoikilitic is added to it through the infiltration of silica; with the presence of shearing the development of chlorite and actinolite has obliterated the original structure and produced the schistosity characteristic of chlorite-actinolite rocks.

SIMILAR ROCKS IN OTHER REGIONS.

These South Mountain volcanics form a part of a belt of similar rocks which have been recently recognized along the Eastern Coast of the United States and Canada.

Such volcanics have been described in New Brunswick by the Canadian geologists—Bailey,[1] Matthew,[2] and Ells.[3]

More recently, in the Sudbury district, similar rocks have been observed by Bell.[4] They have been described in Maine by Shaler,[5] and are recognizable in Canada, Maine, and New Hampshire through the writings of Hunt, Jackson, and Hitchcock, although they were otherwise interpreted by these observers.

Spherulitic volcanics have recently been definitely recognized by W. S. Bayley[6] at Vinal Haven, Maine, and have been studied in detail by Mr. G. O. Smith, of Johns Hopkins University.

They have been identified in the Boston Basin by Wadsworth[7] and by Diller,[8] who has studied them in some detail. The thin sections loaned by the latter for comparative study have already been mentioned as showing a marked similarity to the South Mountain acid volcanics.

The continuation of the South Mountain volcanics in Maryland and Virginia has been studied by Keith.[9] Similar volcanics have been found in North Carolina by Professor Williams,[10] in South Carolina by Lieber,[11] and in Georgia by Professor Pirsson.[12]

In Canada, Maine, in the neighborhood of Boston, and in Missouri[13] the felsites were, like the South Mountain rocks, first regarded as sedimentary in origin, and have only recently been identified as volcanic.

With continued petrographic investigation of the pre-Cambrian rocks of North America volcanics may yet be recognized at other points where the rocks have been interpreted as sedimentary.

In the Lake Superior region they have long been known through the writings of Irving and others, and their extent in that region has recently been still further enlarged.[14]

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[1]Bailey, Report on the pre-Silurian rocks of South New Brunswick: Rept. Can. Geol. Survey, 1877-78 D. D.

[2]Bailey, Matthew, and Ells, Report on Southern New Brunswick: Rept. Can. Geol. Survey, 1878-79.

[3]Ells, Volcanic rocks of Northern New Brunswick: Rept. Can. Geol. Survey, 1879-80, D.

[4]Ibid., 1889-90, F, 1891.

[5]Shaler, Cobscook Bay, Maine: Am. Jour. Sci. (3), Vol. XXXII, 1886, p. 40. Mount Desert: Eighth Ann. Rept. U. S. Geol. Survey, 1886-87, pp. 1043, 1054.

[6]Bull. Geol. Soc. Am., vol. 6, 1894, pp. 474-476.

[7]Wadsworth: Bull. Mus. Comp. Zool. Harvard Coll., Vol. V, No. 13, p. 282.

[8]Diller, op. cit.

[9]Keith, op. cit.

[10]For full statement of distribution of volcanic rocks on Atlantic Coast, see paper by Professor Williams in Jour. of Geology, Vol. II, No. 1, pp. 1-31.

[11]Lieber, Report on the survey of North Carolina, 1856, 2d ed., 1858, p. 31.

[12]A section of a Georgian felsite, loaned by Professor Pirsson, has already been alluded to.

[13]Haworth: Am. Geologist, Vol. I, 1888, p. 280; Bull. Missouri Geol. Survey, No. 5.

[14]U. S. Grant, Volcanic rocks in the Keewatin of Minnesota: Science, Vol. XXIII, Jan. 12, 1884, p. 17.

The reported rarity of volcanic action[1] in America in pre-Cambrian times is perhaps more apparent than real, and is due rather to the failure to recognize the results of such action than to the actual absence of volcanic action.

LITERATURE.

A list of papers in which points of resemblance between ancient and modern acid volcanics have been emphasized, or in which devitrification has been described, and a list of articles on the nature and origin of spherulites, are appended.

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PLATES.

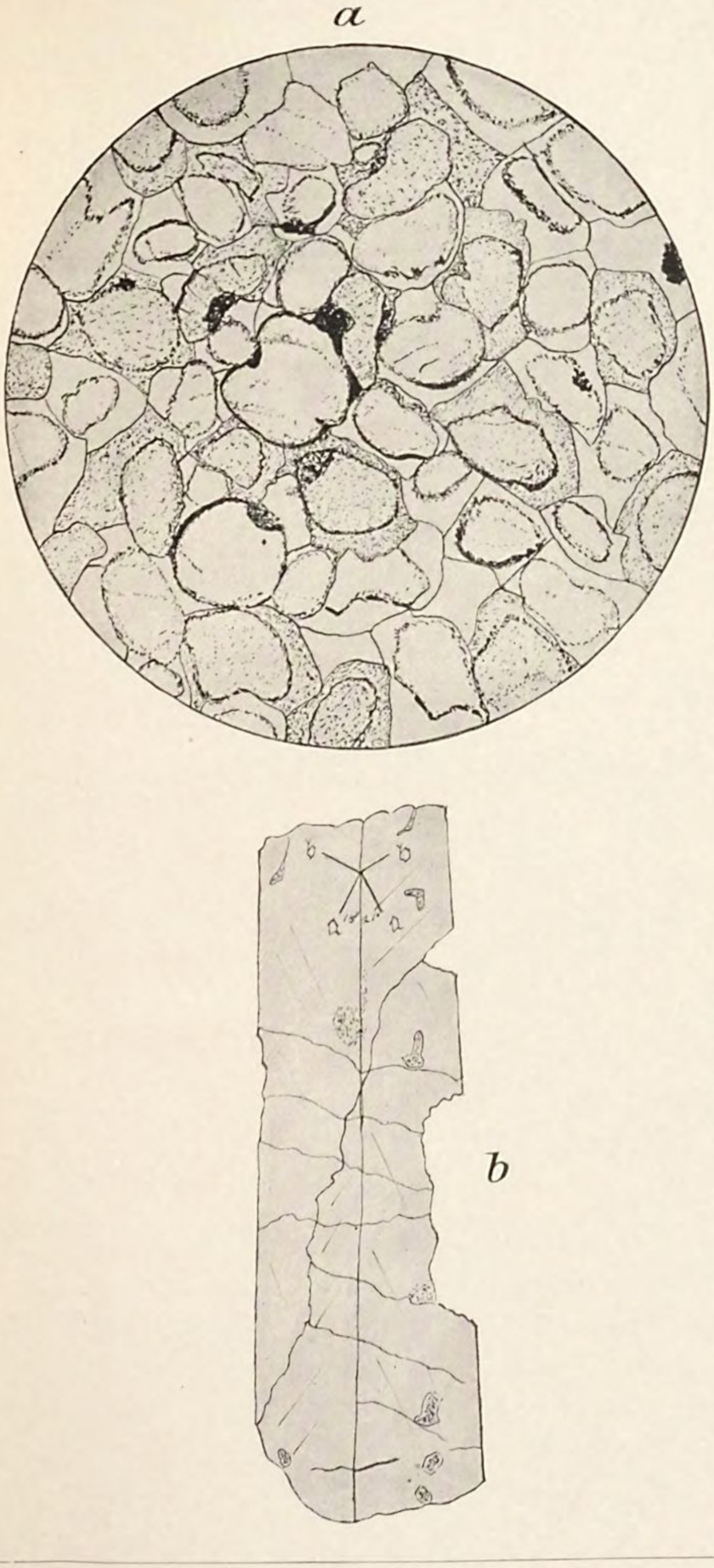
PLATE XV.

PLATE XV.

Fig. *a*.—Quartzite. Specimen I. Slide 1 D. Between Waterloo and the Blue Mountain House. In polarized light, X 32. Illustrates the induration of a sandstone by enlargment of the original grains.

Fig. *b*.—Penetration Manebacher twin of anorthoclase in quartz-porphyry. Specimen 23. Slide 23 D. From well, at depth of 40 feet near Clermont House. In polarized light, X 10 (about).

Piedmontite fills the cavities in the crystal.



THIN SECTIONS.

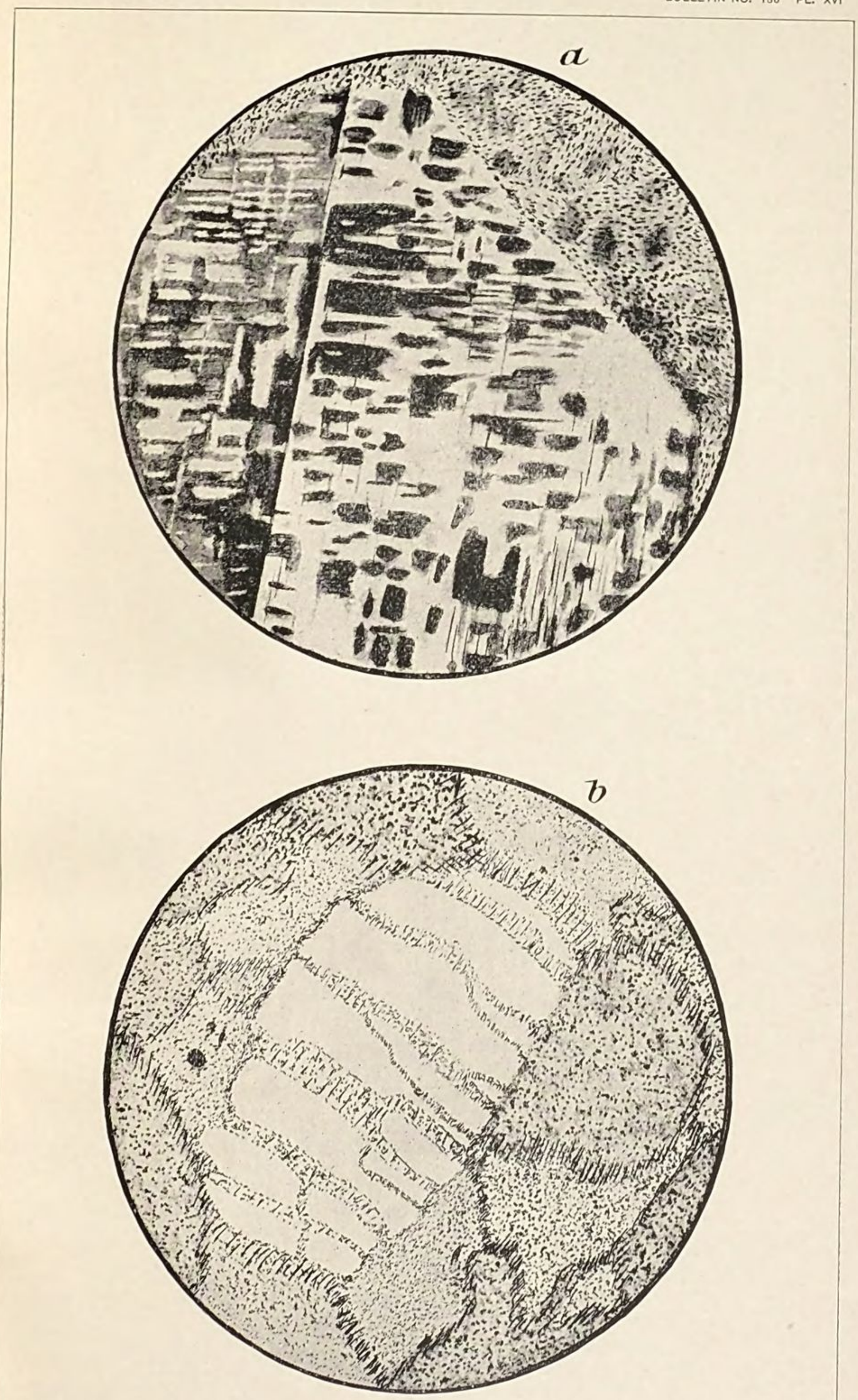
a, Quartzite; *b*, feldspar crystal.

PLATE XVI.

PLATE XVI.

Fig. *a*.—Microperthic structure in a Carlsbad twin of anorthoclase in quartz-porphyry. Specimen 181. Slide 181 D. Near the old viaduct on the Tapeworm Railroad. In polarized light, X 85.

Fig. *b*.—Broken feldspar crystal in quartz-porphyry. Specimen 166. Slide 166 D. Near Gum Spring on the Old Furnace road. In polarized light, X 28. The phenocryst has been broken and pulled apart and the cracks cemented with sericite scales. The ground mass shows the micropoikilitic structure and the micropoikilitic areas are surrounded with sericite scales.



THIN SECTIONS.

a, Microperthitic structure in feldspar; *b*, stretched feldspar crystal.

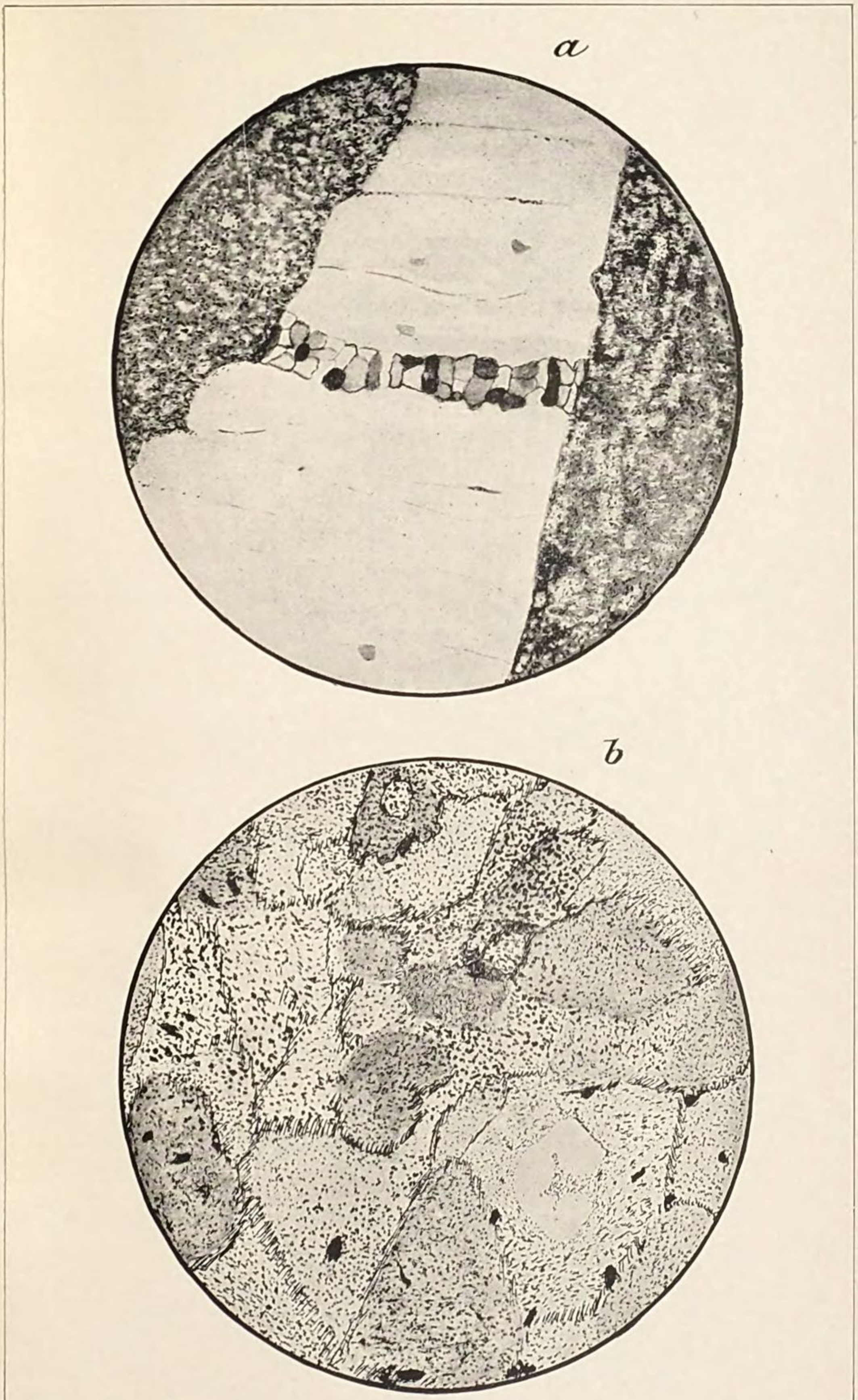
PLATE XVII.

PLATE XVII.

Fig. *a*.—Broken feldspar crystal in quartz-porphyry, Specimen 177, Slide 66. Old Furnace road north of the junction with the Gladhill's road. In polarized light, X 115.

Fig. *b*.—Quartz-porphyry. Specimen 25. Slide 64. Artesian well near Clermont House. In polarized light, X 28.

It is attempted in this figure to show the continuity of orientation of a quartz phenocryst with the micropoikilitic area surrounding it, and to show (in a very crude way) the patchy effect given to the groundmass by the micropoikilitic structure. The quartz areas are bordered by sericite scales.



THIN SECTIONS.

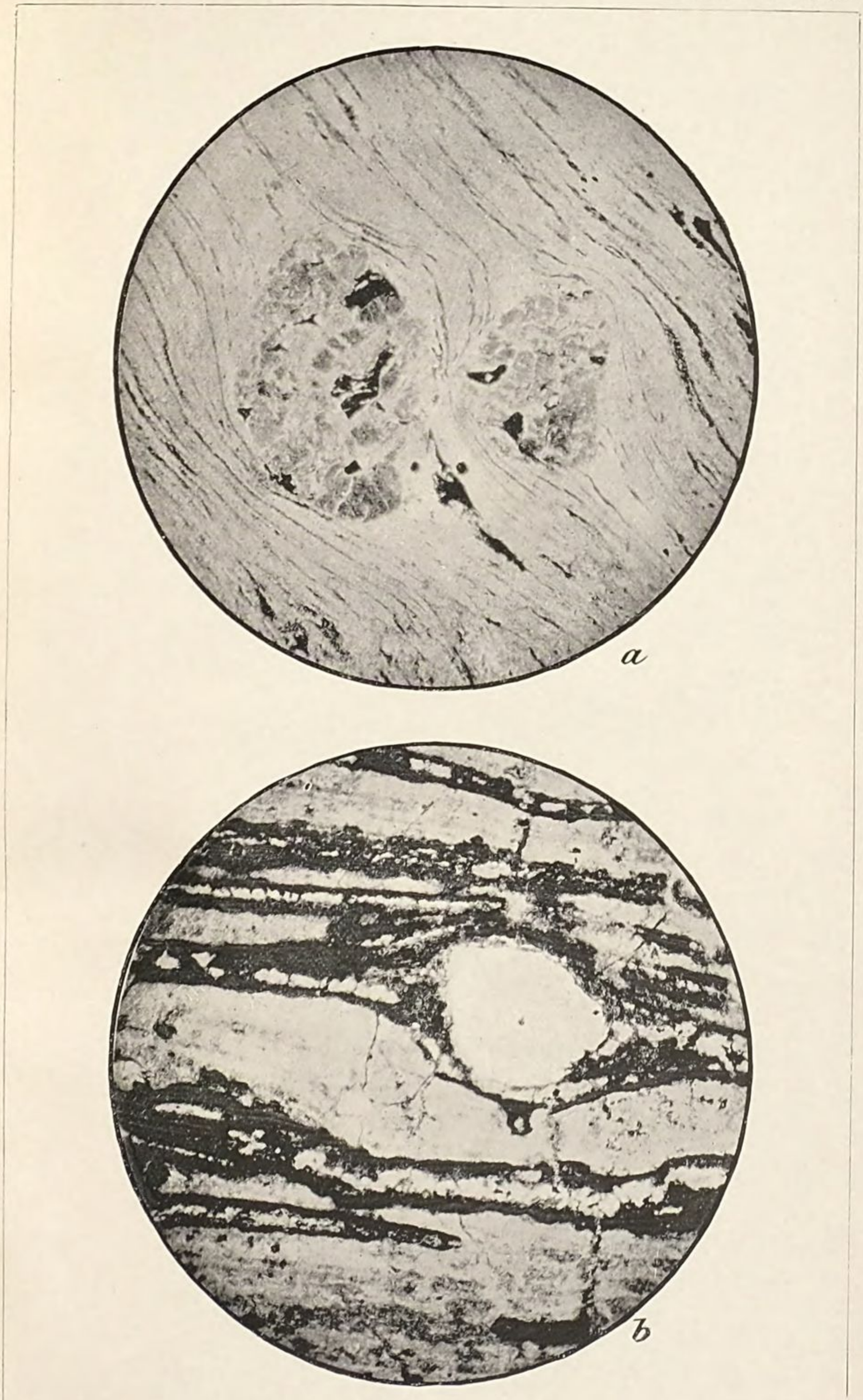
a, Quartz-albite mosaic filling crack in feldspar crystal; *b*, micropoikilitic structure.

PLATE XVIII.

PLATE XVIII.

Fig. *a*.—Flow structure in an aporhyolite. Specimen and slide loaned by Prof. S. L. Powell, of Newbury, S. C. From the South Mountain. In ordinary light, X 24.

Fig. *b*.—Chain spherulites in an aporhyolite. Specimen 34. Slide 34 D. From the neighborhood of the Bigham copper mine. In ordinary light, X 24. Quartz phenocryst (now granulated) inclosed by chain spherulites. Clear spherules in center of dark bands are still preserved.



THIN SECTIONS.

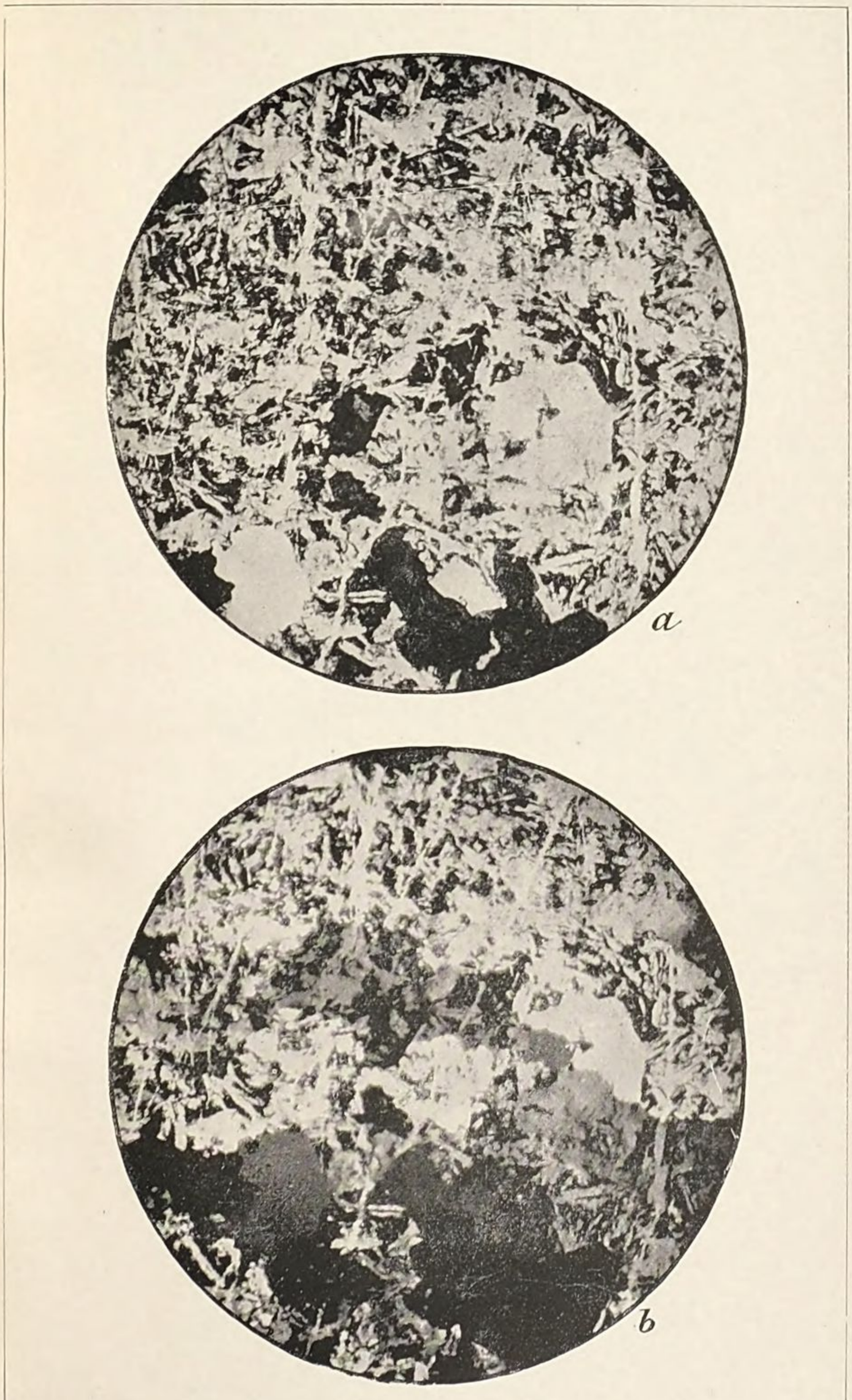
a, Flow structure in an aporhyolite; *b*, chain spherulites in an aporhyolite.

PLATE XIX.

PLATE XIX.

Fig. *a*.—Augite-porphyrite. Specimen 69. Slide 69 D. Gettysburg Railroad, southeast of the Clermont House. In ordinary light, X 24. Ophitic structure outlined by iron oxide. Colorless areas are quartz, and the considerable irregular areas are epidote.

Fig. *b*.—The same. In polarized light, X 24. The quartz breaks up into irregular areas, producing the mottled effect of the micropoikilitic structure.



THIN SECTIONS.

a, *b*, Augite-porphyrite in ordinary and in polarized light.

PLATE XX.

PLATE XX.

PLATE XX.

Fig. *a*.—Perlitic parting in an aporhyolite. Specimen 279. Slide G. H. W. (unnumbered). Raccoon Creek, Franklin County. In ordinary light, X 88.

Fig. *b*.—The same. In polarized light, X 225. A quartz-feldspar mosaic obscures all trace of glassy structures.



THIN SECTIONS.

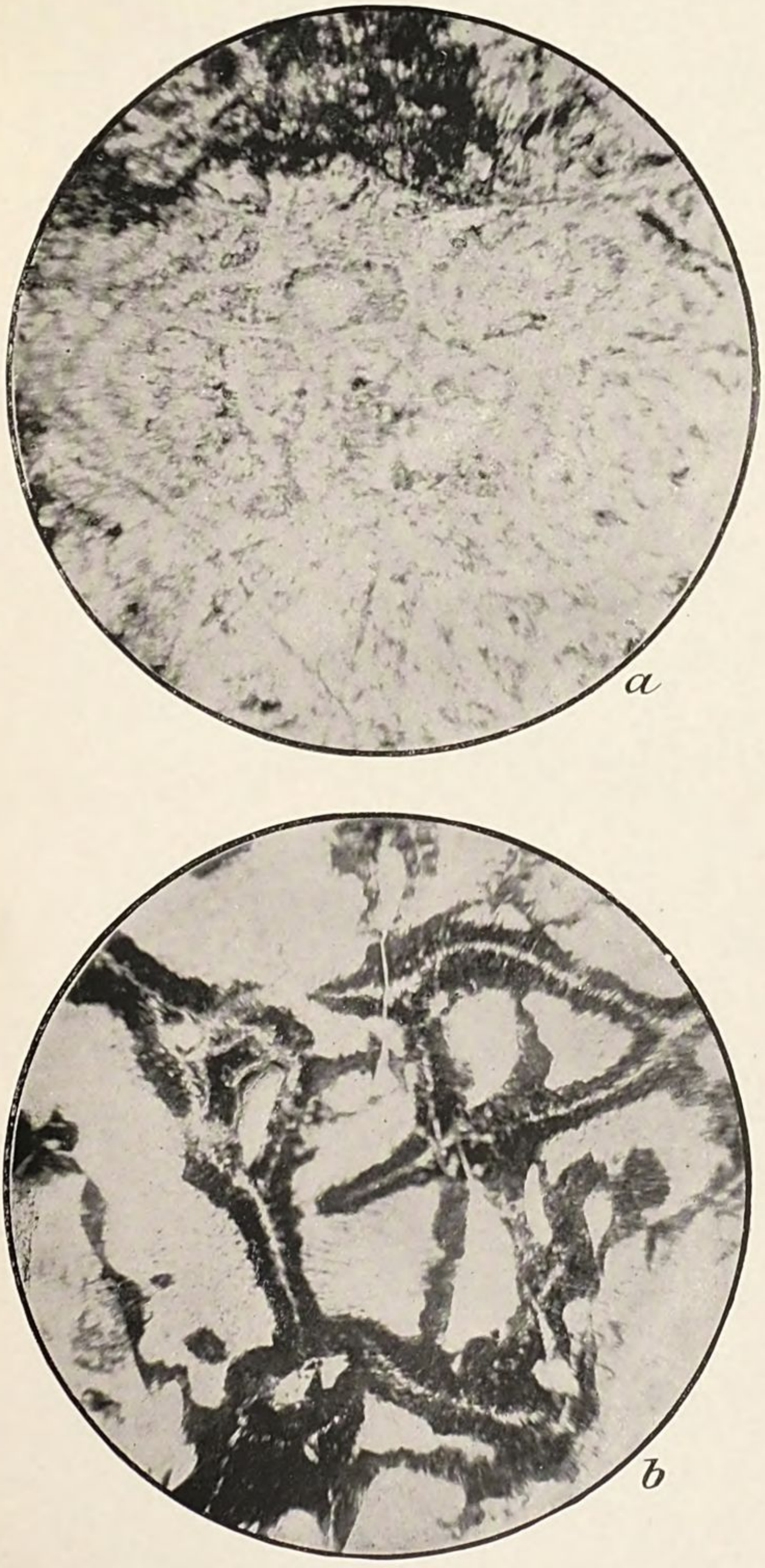
a, *b*, Perlitic parting in an aporhyolite in ordinary and in polarized light

PLATE XXI.

PLATE XXI.

Fig. *a*.—Perlitic parting in an aporhyolite. Specimen G. H. W. Slide G. H. W. (unnumbered). Raccoon Creek, Franklin County. In ordinary light, X 40.

Fig. *b*.—Axiolites in an aporhyolite. Specimen 77. Slide 77. South Mountain. In ordinary light, X 40.



THIN SECTIONS.

a, Perlitic parting in an aporhyolite; *b*, axiolites in an aporhyolite.

PLATE XXII.

PLATE XXII.

Fig. *a*.—Altered spherulite in an aporhyolite. Specimen 280. Slide 280 D. Peach Orchard, southwest flank of Pine Mountain. In ordinary light, X 5. In polarized light the slide shows an even-grained quartz-feldspar mosaic, with the micropoikilitic structure and with no trace of spherulitic crystallization.

Fig. *b*.—An unaltered spherulite in an aporhyolite. Specimen 279. Slide G. H. W. (unnumbered). Raccoon Creek, Franklin County. In ordinary light, X 30. Groundmass devitrified, but spherulitic crystallization still in a large part preserved.



a - ALTERED SPHERULITE IN AN APORHYOLITE.
b - UNALTERED SPHERULITE IN APORHYOLITE.

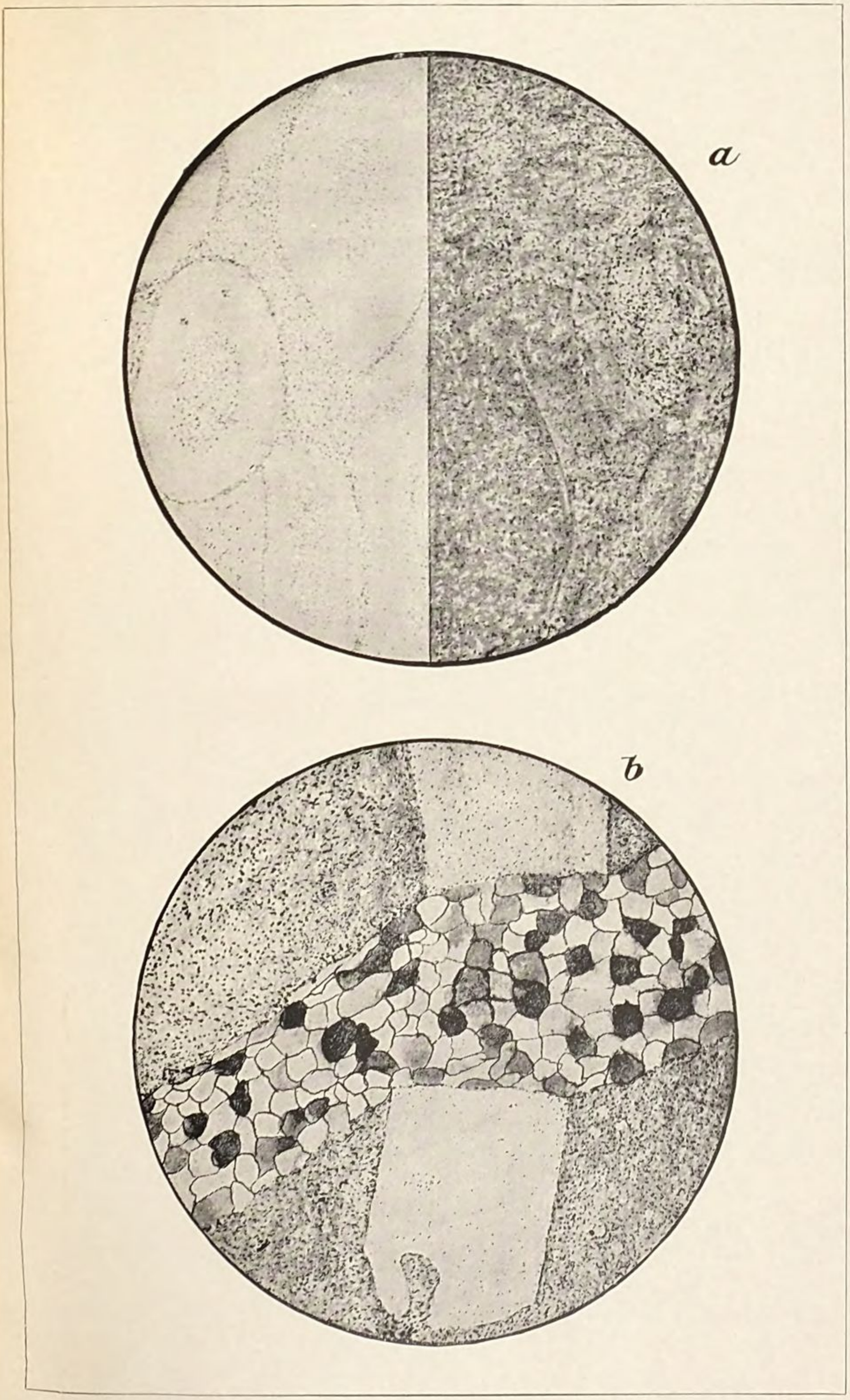
PLATE XXIII.

PLATE XXIII.

Fig. *a*.—Spherulitic aporhyolite. Specimen 226. Slide 226 D. South flank of mountain northeast of the junction of Copper Run and Toms Creek. In polarized light, X 28.

The left-hand side of the figure shows the spherulites in ordinary light; the right-hand shows the same spherulites in polarized light.

Fig. *b*.—Aporhyolite. Specimen 121. Slide 121 D. One-half mile beyond the Bigham copper mine, Old Furnace road. In polarized light, X 80. A crystal of feldspar broken by the cleavage along the plane of former spherulitic crystallization. The figure shows the crystalline silica, which has replaced the spherulitic crystallization and which is much coarser in grain than that of the groundmass.



THIN SECTIONS.

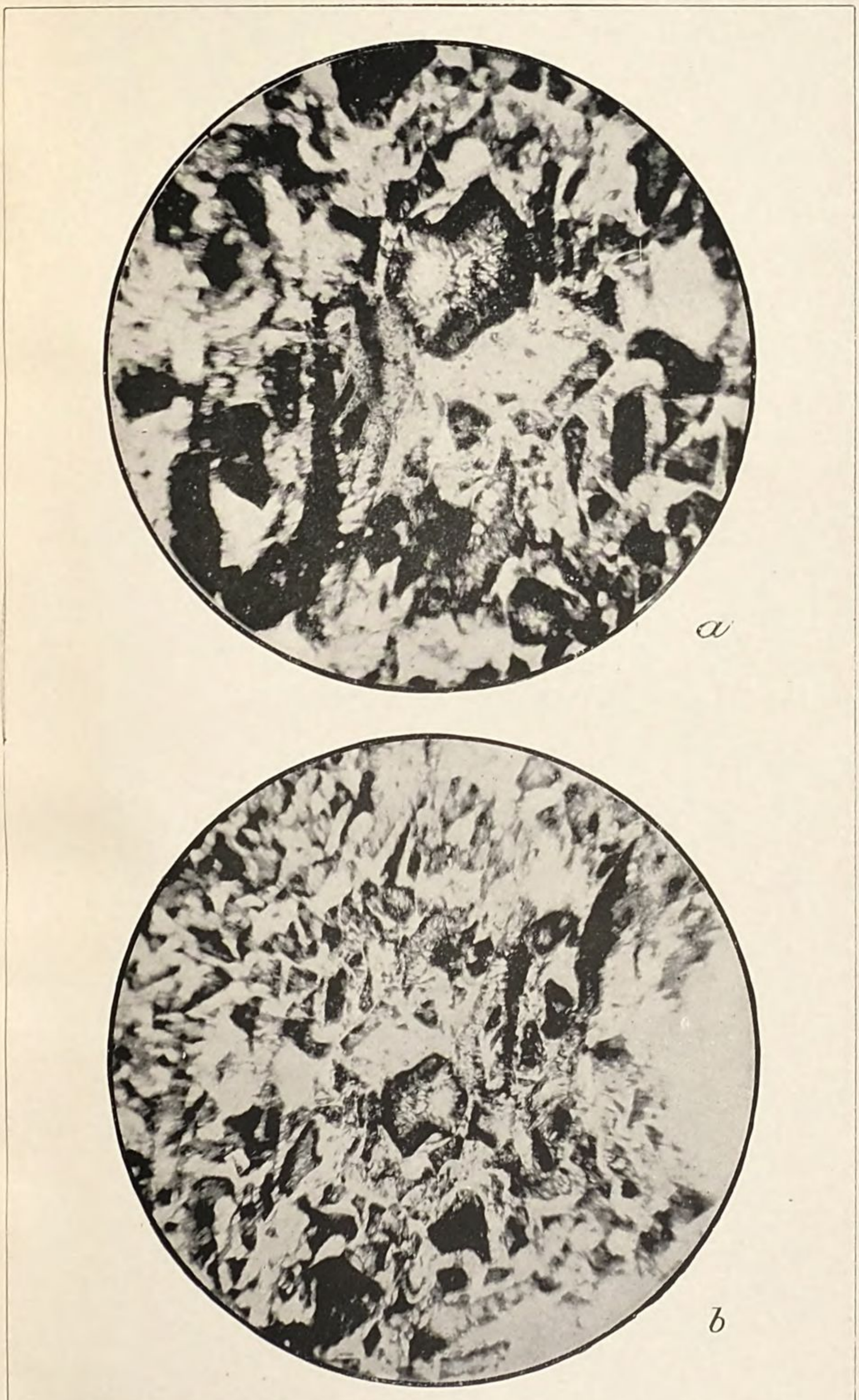
a, Altered spherulites in ordinary and in polarized light; *b*, chain spherulites with phenocryst.

PLATE XXIV.

PLATE XXIV.

Fig. *a*.—Rhyolitic structure in an aporhyolite. Specimen 153. Slide 153. South Mountain. In ordinary light, X 120.

Fig. *b*.—The same. In ordinary light, X 40. The structure is not satisfactorily shown in either figure.



THIN SECTIONS.

a, *b*, Rhyolitic structures in aporhyolites.

PLATE XXV.

PLATE XXV.

Fig. *a*.—Rhyolitic structure in an aporhyolite. Specimen 153. Slide 153. South Mountain. In ordinary light, X 120. Aschen-structur of Müggе.

Fig. *b*.—Piedmontite in an aporhyolite. Specimen 162. Slide 482. Southeast flank of Pine Mountain. In ordinary light, X 120.



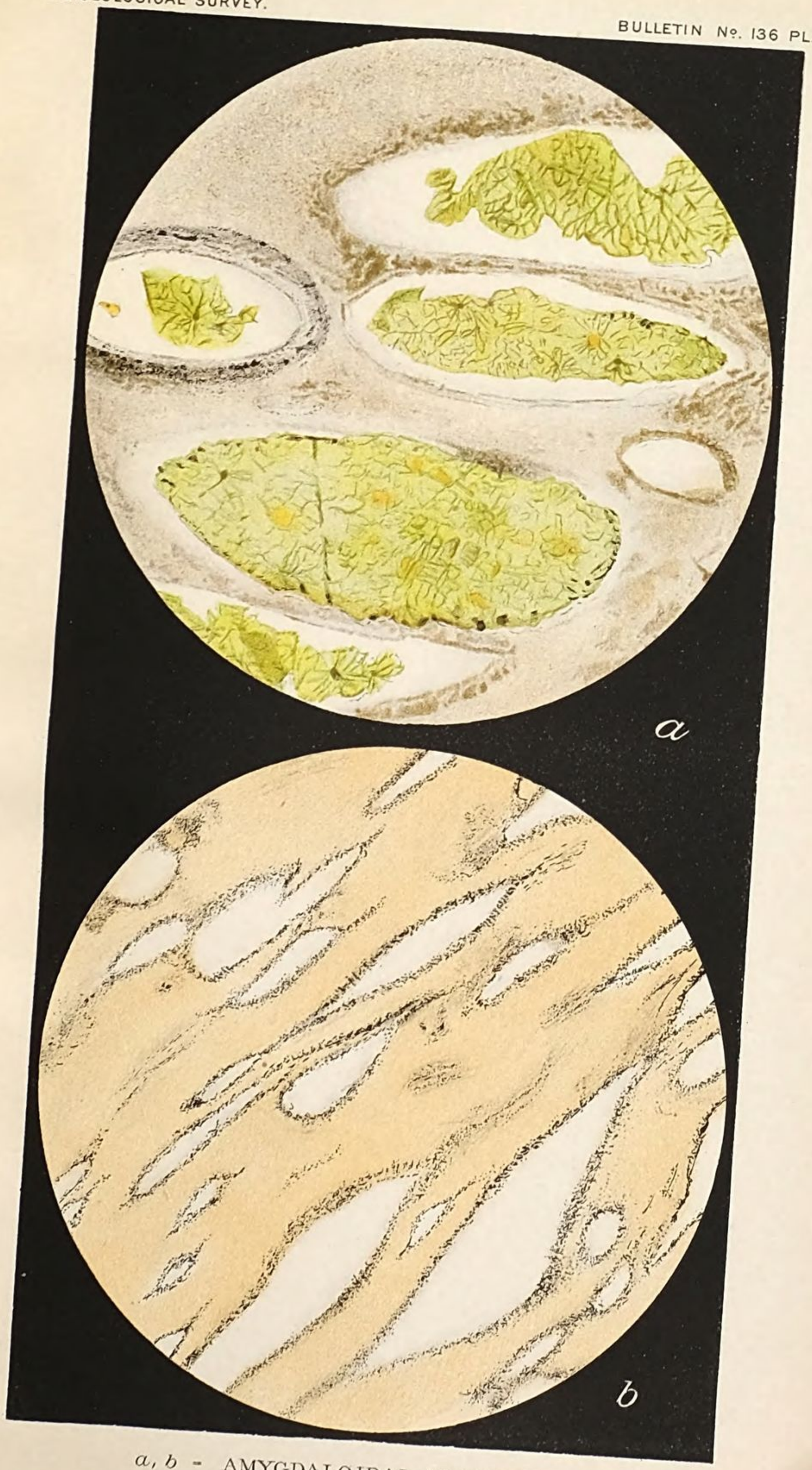
a - RHYOLITE STRUCTURE IN AN APORHYOLITE.
b - PIEDMONTITE.

PLATE XXVI.

PLATE XXVI.

Fig. *a*.—Amygdaloidal aporhyolite. Specimen 48. Slide 48 D. Bigham copper mine. In ordinary light, X 30. Epidote fills the center of the amygdule and quartz surrounds the epidote.

Fig. *b*.—Amygdaloidal aporhyolite. Specimen G. H. W. Slide G. H. W. (unnumbered). Raccoon Creek, Franklin County. In ordinary light, X 30.



a, b - AMYGDALOIDAL APORHYOLITE.

PLATE XXVII.

PLATE XXVII.

Fig. *a*.—Amygdaloidal aporhyolite with tridymite spherulites. Specimen 276. Slide G. H. W. Raccoon Creek, Franklin County. In ordinary light, X 30.

Fig. *b*.—The same. Specimen G. H. W. Slide G. H. W. (unnumbered). Raccoon Creek, Franklin County. In ordinary light, X 30.



a, b = TRIDYMITE SPHERULITES IN AN APORHYOLITE.

PLATE XXVIII.

PLATE XXVIII.

Fig. *a*.—Augite-porphyrite. Specimen 237. Slide 237 D. Head of Minie Branch. In ordinary light, X 120.

Fig. *b*.—Melaphyre. Specimen 87. Slide 87 D. On Gettysburg Railroad, at fourth cut northeast of Monterey Station. In ordinary light, X 120.



a - AUGITE-PORPHYRITE.

b - MELAPHYRE.

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